AN OVERVIEW OF THE FISCAL YEAR 2012 BUDGET PROPOSAL AT THE NATIONAL SCIENCE FOUNDATION AND THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

MARCH 11, 2011

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CONTENTS

MARCH 11, 2011

AN OVERVIEW OF THE FISCAL YEAR 2012 BUDGET PROPOSALS AT THE NATIONAL SCIENCE FOUNDATION AND THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

FRIDAY, MARCH 11, 2011

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph M. Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
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COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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An Overview of the Fiscal Year 2012 Budget Proposals at the National Science Foundation and the National Institute of Standards and Technology

Friday, March 11, 2011

10:00 a.m.- 12:00 p.m.

2318 Rayburn House Office Building

Witnesses

Panel I

Dr. Subra Suresh

Director, National Science Foundation

Dr. Ray Bowen

Chairman, National Science Board

Panel II

Dr. Patrick Gallagher

Under Secretary of Commerce for Standards and Technology and

Director, National Institute of Standards and Technology

HEARING CHARTER

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

An Overview Of The Fiscal Year 2012 Budget Proposals At The National Science Foundation And The National Institute Of Standards And Technology

FRIDAY, MARCH 11, 2011
10:00 A.M.-12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Friday, March 11, 2011, the House Committee on Science, Space, and Technology will hold a hearing to examine the Administration's proposed fiscal year 2012 (FY12) budget request for the National Science Foundation and the National Institute of Standards and Technology. There will be two panels, one focused on NSF, and the other on NIST. An Administration witness will provide testimony for each agency, and the National Science Board Chair will discuss the National Science Foundation request.

Witnesses

Panel I

- **Dr. Subra Suresh**, Director, National Science Foundation
- **Dr. Ray Bowen**, Chairman, National Science Board

Panel II

- **Dr. Patrick Gallagher**, Under Secretary of Commerce for Standards and Technology and Director, National Institute of Standards and Technology

Hearing Overview

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense . . . " With an annual budget of about $6.9 billion (FY 2010), it is the funding source for approximately 20 percent of all federally supported basic research conducted by America's colleges and universities.

The National Institute of Standards and Technology (NIST) is a non-regulatory agency within the Department of Commerce. Originally founded in 1901 as the National Bureau of Standards, NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. By working closely alongside industry, NIST has become recognized as a provider of high-quality information utilized by the private sector.

While NSF and NIST have very different organizational structures and functions, these two agencies, along with the Department of Energy's Office of Science, have been consistently recognized for their ties to the economic competitiveness and national security of the United States.

NSF Overview

NSF is the primary source of federal funding for non-medical basic research, providing approximately 40 percent of all federal support, and serves as a catalyst for science, technology, engineering, and mathematics (STEM) education improvement at all levels of education. It supports the fundamental investigations that ultimately serve as the foundation for progress in nationally significant areas such as national

security, technology-driven economic growth, energy independence, health care, nanotechnology, and networking and information technology.

Through roughly 10,000 new awards per year, NSF supports an average of 200,000 scientists, engineers, educators and students at universities, laboratories and field sites all over the U.S. and throughout the world. These grants fund specific research proposals that have been judged the most promising by a rigorous and objective merit-review system. In the past few decades, NSF-funded researchers have won more than 180 Nobel Prizes.

National Science Foundation (NSF)

National Science Foundation (NSF) Spending
(dollars in millions)

Account	FY08 Actual	FY10 Enacted	FY11 Request	FY12 Request	FY12 Request versus FY10 Enacted $	FY12 Request versus FY10 Enacted %
Research and Related Activities (RRA)	**4853.2**	**5563.9**	**6018.8**	6253.5	**689.6**	**12.4**
Biological Sciences (BIO)	*615.6*	*714.5*	*767.8*	*794.5*	*79.6*	*11.2*
Computer and Info. Science and Engineering (CISE)	*535.3*	*618.8*	*684.5*	*728.4*	*109.6*	*17.7*
Engineering (ENG)	*649.5*	*743.9*	*825.7*	*908.3*	*164.4*	*22.1*
Geosciences (GEO)	*757.9*	*889.6*	*955.3*	*979.2*	*89.5*	*10.1*
Mathematical and Physical Sciences (MSP)	*1171.1*	*1351.8*	*1409.9*	*1432.7*	*80.9*	*6.0*
Social, Behavioral, and Economic Sciences (SBE)	*227.9*	*255.3*	*268.8*	*301.1*	*45.9*	*18.0*
Cyberinfrastructure (OCI)	*185.2*	*214.3*	*228.1*	*236.0*	*21.7*	*10.1*
International Science and Engineering (OISE)	*47.8*	*47.8*	*53.3*	*58.0*	*10.2*	*21.3*
Polar Programs (OPP)	*447.1*	*451.2*	*527.9*	*477.4*	*26.3*	*5.8*
Integrative Activities (IA)	*214.5*	*275.0*	*295.9*	*336.3*	*61.2*	*22.3*
U.S. Arctic Research Commission	*1.5*	*1.6*	*1.6*	*1.6*	*0*	*1.3*
Education and Human Resources (EHR)	**766.3**	**872.8**	**892.0**	**911.2**	**38.4**	**4.4**
Major Research Equipment & Facilities Const (MREFC)	**166.9**	**117.3**	**165.2**	**224.7**	**107.4**	**91.6**
Agency Operations & Award Management	**282.0**	**300.0**	**329.2**	**357.7**	**57.7**	**19.2**
National Science Board (NSB)	**3.8**	**4.5**	**4.8**	**4.8**	**.3**	**6.6**
Office of Inspector General (OIG)	**11.8**	**14.0**	**14.4**	**15**	**1.0**	**7.1**
Totals:	**6084.0**	**6872.5**	**7424.4**	**7767.0**	**894.5**	**13.0**

NSF Budget Summary

The FY 12 budget request for NSF is $7.7 billion, an increase of 13 percent, or $894.5 million over the FY 10 enacted level (not including any carryover from the $3 billion NSF received from ARRA funding). The request continues to keep NSF on a doubling path for funding as set out in the America COMPETES Act and America COMPETES Reauthorization Act. The budget for NSF is divided into three main accounts: Research and Related Activities, Education and Human Resources, and Major Research Equipment and Facilities Construction.

Research and Related Activities (RRA)

The FY 12 budget request includes $6.3 billion for Research and Related Activities (RRA), an increase of $690 million or 12.4 percent over FY 10 enacted. RRA is made up primarily of six disciplinary directorates: non-biomedical life sciences (BIO); computer sciences (CISE); engineering (ENG); geosciences (GEO); math and physical sciences (MPS); and social, behavioral, and economic sciences (SBE). Each of these directorates get significant increases in the FY 12 budget request ranging from six percent for MPS to 22.1 percent for ENG. New programs established as part of the increased research funding request for FY 12 include $35 million for a nanotechnology manufacturing initiative, $40 million in next-generation robotics technologies, and $96 million for an interdiscipli-

nary program to eventually replace computer chip technologies. In addition, $87 million is requested for advanced manufacturing activities including expanded university-industry research partnerships and regional innovation ecosystems and clean energy manufacturing research. Another $117 million is requested for "cyber-infrastructure" activities to accelerate the pace of discovery and $12 million for a "new program that will fund a suite of activities that promote greater interdisciplinary research."

As part of the Science, Engineering and Education for Sustainability (SEES) program that crosses all NSF directorates and has a goal of advancing "climate and energy science, engineering, and education to inform the societal actions needed for environment and economic sustainability and sustainable human well-being," the FY 12 budget request is $998.1 million, an increase of$337.5 million or 51 percent.

In addition, the FY 12 budget request also includes a plan to invest broadband spectrum receipts in a variety of areas, including $150 million to NSF in FY 12 and $1 billion total over a five-year period for targeted research on experimental wireless technology testbeds, more flexible and efficient use of the radio spectrum, and cyber-physical systems such as wireless sensor networks for smart buildings, roads, and bridges. NSF's participation is a piece of the $3 billion WIN fund.

Education and Human Resources (EHR)

EHR funds most of NSF's activities that support K-12 STEM education and the majority of activities that support undergraduate STEM education. EHR also funds most of NSF's graduate fellowship and traineeship programs.

The FY 12 budget request for EHR is $911 million, a $38.4 million or 4.4 percent increase over FY l0. The Administration continues to offer a mixed message regarding the treatment of EHR relative to the healthy increase for RRA. While calling for an investment of $3.4 billion in STEM education activities across the federal government, a number of proven NSF initiatives are being eliminated, reduced, or reprogrammed to make way for new or expanded programs. Like last year's request, the FY 12 budget request continues to shift a greater responsibility for STEM education to the Department of Education while maintaining NSF primarily as a research agency.

New funding in the FY 12 budget request includes an additional $20 million for a Transforming Broadening Participation through STEM (TBPS) pilot program to seek innovative solutions for broadening participation in STEM at the undergraduate level. This is part of an overarching realigned program called Broadening Participation at the Core (BPAC), which also houses several underrepresented population programs. The BPAC program total request is $156 million, a $21 million or 23.3 percent increase over FY l0. Research programs focused on gender and persons with disabilities have been moved from this Division to the Division of Research on Learning in Formal and Informal Settings and funding under the request is cut by 8.7 percent to $17 million. It is unclear why this shift in funding emphasis and program location is warranted.

Additionally, the FY 12 budget request includes $40 million in funding for a new teacher-training research and development program, split evenly between K-12 teachers and undergraduate teachers. At the same time, the budget request for Noyce Scholarships is $45 million, a decrease of $10 million or 18.2 percent and the Math and Science Partnership is $48.2 million, also a decrease of $10 million or 17.2 percent.

Likewise, the Administration's budget request places a high priority on Graduate Research Fellowships (GRF) by increasing the funding to $134.6 million, a 31.2 percent increase over FY I0, while essentially flatlining the Integrative Graduate Education and Research Traineeship Program (IGERT) at $30.2 million and moving to eliminate the Graduate STEM Fellows in K-12 Education (GK-12). While recognizing the flexibility that GRFs provide graduate students, IGERT is also an extremely well regarded and effective program that by design supports cutting-edge interdisciplinary science. The reason for this continued unbalanced treatment of two equally important and effective graduate student programs is unclear.

Major Research Equipment and Facilities Construction (MREFC)

The MREFC account funds the construction of large research facilities, such as telescopes and research ships. Funding for the design, operation and management of these major user facilities is included in the R&RA budget.

The FY 12 budget request includes $224.7 million for the Major Research Equipment and Facilities Construction (MREFC) account. This is a 91.6 percent increase from FY 10, but the FY 10 amount does not include $146 million provided in ARRA funding for the Advanced Technology Solar Telescope (ATST). A bulk of MREFC funding in FY 12 includes $87.9 million for the second year construction of the National Ecological Observatory Network (NEON), which will collect data across the U.S. on the impacts of climate change, land use change, and invasive species. Another $102.8 million is requested for the fourth year of construction of the Ocean Observatories Initiative (00I), an integrated network of instrumentation that will provide continuous and interactive access to the ocean. 001 also received $157 million in ARRA funding in FY 09.

Agency Operations and Award Management (.4. OAM)

The AOAM account funds the internal operations of NSF. The FY 12 budget request includes $357.7 million for AOAM. This is a 19.2 percent increase of$57.7 million. $44.7 million of this increase is related to the expiration of the NSF building leases in 2013. A new lease will need to be signed in FY I2.

National Institute of Standards and Technology (NIST)

National Institute of Standards and Technology (NIST) Spending
(dollars in millions)

Account	FY08 Actual	FY10 Enacted	FY11 Request	FY12 Request	FY12 Request versus FY10 Enacted $	FY12 Request versus FY10 Enacted %
Scientific & Technical Research and Services (STRS)	**440.5**	**515.0**	**584.5**	**678.9**	**163.9**	**31.8**
Construction of Research Facilities (CRF)	**160.5**	**147.0**	**124.5**	**84.6**	**(62.4)**	**(42.4)**
Industrial Technology Service (ITS)	**154.8**	**194.6**	**209.6**	**237.6**	**43.0**	**22.1**
Technology Innovation Program (TIP)	*65.2*	*69.9*	*79.9*	*75.0*	*5.1*	*7.3*
Manufacturing Extension Partnership (MEP)	*89.6*	*124.7*	*129.7*	*142.6*	*17.9*	*14.4*
*Advanced Manufacturing Consortia**	--	--	--	*12.3*	*12.3*	*100.0*
*Baldrige Performance Excellence Program** **	*7.9*	*9.6*	*9.9*	*7.7*	*(1.9)*	*(19.8)*
Totals:	**755.8**	**856.6**	**918.6**	**1001.1**	**144.5**	**16.9**

*new initiative
**in FY11 funded under STRS account

NIST Overview

NIST operates two main research laboratories in Gaithersburg, MD, and Boulder, CO, as well as radio stations in Hawaii and Colorado. NIST also maintains partnerships with the Hollings Marine Labs in Charleston, SC, the JILA joint institute operated with the University of Colorado, and the Center for Advanced Research in Biotechnology (CARB) and the Joint Quantum Institute, both operated in conjunction with the University of Maryland.

NIST employs about 3,100 scientists, engineers, technicians, and support and administrative personnel. Also, NIST annually hosts about 2,600 associates and facility users from academia, industry, and other government agencies. In addition, NIST partners with 1,600 manufacturing specialists and staff at about 400 Manufacturing Extension Partnership (MEP) service locations around the country. Of note, NIST scientists have earned three Nobel Prizes over the last 15 years, and NIST led a building and fire safety investigation to study the structural failure and subsequent progressive collapse of the World Trade Center buildings following the terrorist attacks of 2001.

NIST Reorganization

In October 2010, NIST reorganized its structure, with the goal of aligning its research units according to a structure defined around mission instead of scientific disciplines. The realignment is expected to allow increased decision-making flexibility, greater accountability for customer product and services delivery, and for more interdisciplinary research to be conducted at NIST. Finally, the number of operational units dropped from ten to six, creating a more streamlined management structure.

NIST Budget Summary

In FY 12, the Administration has requested a funding level of $1 billion or a 16.9 percent increase from FY 10 enacted funding for

the NIST. The budget request would provide $678.9 million for NIST's core Scientific and Technical Research and Services (STRS); $84.6 million for Construction of Research Facilities (CRF); $142.6 million for the Manufacturing Extension Partnership (MEP) program; and $75.0 million for the Technology Innovation Program (TIP).

Research and Facilities

The FY 12 NIST budget request is $678.9 million for the Agency's Scientific and Technical Research Services (STRS), an increase of $163.9 million or 31.8 percent, and includes $168 million in specific initiatives to address national priorities related to cyber infrastructure, technology interoperability, nanotechnology, and advanced manufacturing and materials. The STRS FY 12 request continues the Administration's plan to double funding for key basic research agencies.

The FY 12 budget request for Construction of Research Facilities (CRF) is $84.6 million, a 42.4 percent decrease from FY 10 enacted. The significant decrease represents the completion of several major renovation projects at the laboratory facilities in Boulder, CO. CRF funding would support maintenance and repair of existing NIST buildings as well as continue the interior renovation efforts of the Boulder lab Building 1 ($25.4 million).

In order to advance measurement science, standards, and technology, NIST currently operates six laboratory units:

- **Material Measurement Laboratory (MML)** The MML serves as the national reference laboratory for measurements in the chemical, biological, and material sciences. The MML provides measurement services used by a broad set of industries including but not limited to: healthcare (biomarkers), renewable energy (measuring the quality of fuels) and forensic science (biometric identification techniques).
- **Physical Measurement Laboratory (PLM)** The PLM develops and disseminates the national standards of measurement, e.g., length, mass, force and shock, acceleration, time and frequency, electricity, temperature, humidity and pressure. This information supports consistent timekeeping, on which many technologies like GPS rely; and underpins the safety of our national electricity grid.
- **Engineering Laboratory (EL)** The EL develops and disseminates advanced manufacturing and construction technologies, guidelines, and services to the U.S. manufacturing and construction industries. Examples of EL work include researching ways to reduce the spread of fire in residential buildings and developing performance metrics for advanced manufacturing processes.
- **Information Technology Laboratory (ITL)** The ITL develops and disseminates standards, measurements, and testing for interoperability, security, usability, and reliability of information systems, including cyber security standards and guidelines for federal agencies and U.S. industry. ITL works in areas such as cloud computing, health information technology, and advanced voting technologies.

- **Center for Nanoscale Science and Technology (CNST)** is the only national nanotechnology center focused on commerce. The facility offers shared space—utilized by a variety of public and private stakeholders—for nanoscale fabrication and measurement and develops innovative nanoscale measurement and fabrication capabilities.
- **Center for Neutron Research (NCNR)** provides a national user facility, utilized by universities, government and industry, to study neutron-based measurement capabilities. The level of measurement capabilities is unavailable anywhere else in the country, allowing researchers to answer questions in nanoscience and technology with a broad range of applications.

Strategic and Emerging Research Initiative (SERI): Within its laboratory programs, NIST also operates a program ($10 million requested in FY 12) providing flexibility to target research efforts in certain "high-risk, high-payoff" areas of interest. Current areas of focus include quantifying greenhouse gas measurements, standards for remediation and decontamination of structures contaminated by methamphetamine laboratories, biomanufacturing, and characterizing nanoparticles currently used in consumer products.

Industrial Technology Services (ITS)

In addition to the laboratories, NIST manages several extramural programs supporting industry. The FY 12 $142.6 million request for the Manufacturing Extension Partnership (MEP) program is a $17.9 million or 14.4 percent increase from the FY 10 enacted level. The MEP program is a public/private partnership run by Centers in all 50 states and Puerto Rico that provides technical assistance for small and medium-sized manufacturers to modernize their operations and adapt to foreign competition. MEP Centers are supported by equal contributions from federal funds, state funds, and industry client fees. The requested increase would expand the program in support of the Administration's initiatives to reinvent domestic manufacturing to create jobs and respond to future challenges and opportunities.

The FY 12 request for the Technology Innovation Program (TIP) is $75 million, a $5.1 million increase over FY 10 enacted. TIP awards cost-shared grants to small companies and joint ventures for the development of high-risk, high-reward technologies that meet critical national needs. This program was created by the 2007 America COMPETES Act but was not reauthorized in the 2010 America COMPETES Reauthorization Act (P.L. 111-358).

The Baldrige Performance Excellence Program (BPEP) would receive $1.9 million less than FY 10 enacted in the FY 12 budget request, reflecting the Administration's goal of transitioning the program to privately funded sources. Baldrige provides criteria and evaluation of successful strategies and performance practices across an array of industries.

New in FY 12 is the Advanced Manufacturing Technology Consortia (AMTech) Program, with a $12.3 million request. Modeled after the Nanoelectronics Research Initiative (NRI), a partnership between NSF, NIST, industry, and universities across the nation,

the AMTech program would align industry needs with university research in innovative manufacturing. The program would fund facilities, equipment, and research at universities and government laboratories to address long-term research needs of the manufacturing industry.

Public Safety Innovation Fund

The FY 12 budget request includes a plan to invest broadband spectrum receipts in a variety of areas, including $100 million annually provided to NIST for 2012-2016 for research supporting the development and promotion of wireless technologies to advance public safety, Smart Grid, and other broadband capabilities. NIST's participation is a piece of the $3 billion WIN fund.

Chairman HALL. Okay, the Committee on Science, Space, and Technology will come to order. And good morning and welcome to today's hearing entitled "An Overview of the Fiscal Year 2012 Budget Proposal at the National Science Foundation and the National Institute of Standards and Technology." That information is in your packets and contained in the written testimony biography and the Truth in Testimony disclosure for today's witnesses.

And today's hearing includes two panels. Our first panel will feature National Science Foundation Director Dr. Subra Suresh. I am going to mispronounce that. Subra Suresh. And my name is Hall. You spell it with an A too, not an E. And National Science Board Chairman Dr. Ray Bowen, a man I have known and admired for many years.

Our second panel will feature the Under Secretary of Commerce for Standards and Technology and Director of the National Institute of Standards and Technology, Dr. Patrick Gallagher.

I recognize myself for five minutes for an opening statement. I am pleased to discuss the Fiscal Year 2012 budget request for the two agencies within the Science, Space, and Technology Committee's jurisdiction. The National Science Foundation, NSF, and the National Institute of Standards and Technology, NIST. There is no denying that both of these agencies make vital contributions to our nation's competitiveness, and this committee has long bipartisan records of support for these agencies and their contributions.

NSF's work is diverse and far-reaching. NSF's investments have yielded barcodes, the sign language dictionary, MRIs, and Google. In the last year alone, the foundation has supported research ranging from new techniques to combat the flu virus to sustaining the budding field of nanoelectronics, whatever that is, through ways to minimize the negative impacts of sunspots on communication technology.

NSF is the primary source of Federal Government support for our colleges and universities as most NSF investments are for merit-based, peer-reviewed research conducted in university laboratories across the nation. In fact, I suspect that every one of our districts has benefited from NSF funding in one form or the other.

NIST is a non-regulatory laboratory of the Federal Government tasked with innovation and industrial competitiveness by advancing measurement science, standards, and technology. They work alongside the industry to make sure their activities improve the quality of life for Americans and the economic security of our nation.Although we may not be aware of NIST impact on our lives, their work is making things run smoothly for us from online security to health information technology.

I note that the request for both of these agencies in Fiscal Year 2012 are significant. NSF's budget would increase by 13 percent over Fiscal Year 2010's appropriations, and NIST budget would increase by almost 17 percent.

I must say, given the current economic realities, I am gravely concerned that we can't afford continued spending at these rates, but we will look closely at everything. I applaud the Administration's efforts to terminate ineffective programs and make reductions in worthy areas, but I am told that these cuts and reductions

do not go far enough, particularly when there are just as many new and/or duplicative programs created in the process.

I also remain very concerned that the Administration continues to place a greater emphasis on specific applied research areas at these agencies, whose core missions are and should remain basic, fundamental research.

Regardless, the committee appreciates the opportunity to learn more about how Fiscal Year 2012 funds would be utilized by NSF and NIST. And I thank our witnesses for their time and flexibility in conducting this hearing today, and those who support them in their appearance here today.

I now am very pleased to recognize Ms. Johnson for her opening remarks.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH M. HALL

I am pleased to discuss the fiscal year 2012 budget request for two agencies within the Science, Space, and Technology Committee's jurisdiction: the National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST).

There is no denying that both of these agencies make vital contributions to our Nation's competitiveness, and this Committee has a long, bipartisan record of support for these agencies and their contributions.

The National Science Foundation's work is diverse and far-reaching. NSF investments have yielded bar codes, the sign language dictionary, MRIs, and Google. In the last year alone, the Foundation has supported research ranging from new techniques to combat the flu virus to sustaining the budding field of nanoelectronics to ways to minimize the negative impacts of sunspots on communication technology. NSF is the primary source of federal government support for our colleges and universities, as most NSF investments are for merit-based, peer-reviewed research conducted in university laboratories across the Nation. In fact, I suspect every one of our districts have benefited from NSF funding in one form or the other.

The National Institute of Standards and Technology is a non-regulatory laboratory of the federal government tasked with innovation and industrial competitiveness by advancing measurement science, standards and technology. They work alongside industry to make sure their activities improve the quality of life of Americans and the economic security of our nation. Although we may not be aware of NIST's impact on our lives, their work is making things run smoothly for us, from online security to health information technology.

I note that the requests for both of these agencies in fiscal year 2012 are significant; NSF's budget would increase by 13 percent over fiscal year 2010's appropriation, and NIST's budget would increase by almost 17 percent. Given the current economic realities, I am greatly concerned that we simply cannot afford to continue spending at these rates.

I applaud the Administration's efforts to terminate ineffective programs and make reductions in worthy areas, but I am afraid these cuts and reductions do not go far enough, particularly when there are just as many new and/or duplicative programs created in the process. I also remain very concerned that the Administration continues to place a greater emphasis on specific applied research areas at these agencies whose core missions are and should remain basic, fundamental research.

Regardless, the Committee appreciates the opportunity to learn more about how fiscal year 2012 funds would be utilized by NSF and NIST, and I thank our witnesses for their time and flexibility in conducting this hearing today.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and let me welcome Dr. Suresh and Dr. Bowen, who will be testifying before our Committee for the first time this morning. And we will welcome back Dr. Gallagher who we will hear from in the second panel.

The purpose of today's hearing is to examine the President's Fiscal Year 2012 budget request for the National Science Foundation and the National Institute of Standards and Technology, two agencies that are key to our ability to spur innovation and improve

STEM education in this country. I am pleased to see that the President's budget request shares this Committee's goal, as reflected in America COMPETES Act and the America COMPETES Reauthorization Act, of doubling the budgets of these agencies, laying a strong foundation for our nation's future competitiveness.

This President understands that our future economic growth and therefore our ability to reduce our debt in the future is tied very strongly to the investments we make in science and innovation today.

In contrast, if the funding bill H.R. 1, passed by the House last month, is enacted, we will be moving exactly in the wrong direction. I share the well-founded concern of many Members if we don't act to address our deficit, we will be leaving our children and grandchildren with a growing debt that they will spend their lifetimes trying to pay down. However, I am dumbfounded we are even considering cutting the very investments that will reduce our debt over the long run and ensure that there are well-paying jobs for future generations and help our young people develop the skills that they need for these jobs.

The lasting consequences of the proposed cuts to science and education are enormous and go well beyond the jobs at research facilities that would be lost today. Fortunately the President, as evidenced by his Fiscal Year 2012 budget request, recognizes the importance of these investments.

I look forward to hearing from Dr. Suresh and Dr. Bowen about some of the new research initiatives and directions being proposed by NSF in this budget as well as hearing from Dr. Gallagher about NIST's new initiatives.

Overall, I am quite happy with the request. I am particularly pleased with the robust research budget being proposed by NSF and its efforts to provide opportunities to address critically important interdisciplinary research needs. I am also pleased to hear that NIST's budget request includes sustaining commitments to addressing critical challenges in manufacturing, clean energy, and cybersecurity.

That being said, I do have a couple of specific concerns. First, this administration has made a strong commitment to STEM education, and I do not underestimate the impact of having the President himself publicly engaged in this critical issue. Once again, however, the administration is proposing a budget for NSF's education directorate that barely keeps pace with inflation.

I support an increased role for the Department of Education in STEM education, and I am happy to hear that collaboration between the agencies has increased significantly. Nevertheless, I think Chairman Hall will be with me when we say that this Committee will continue to stand up for the very important and unique role of NSF in STEM education.

I understand that NSF funds education programs across the entire agency, so maybe we need to look at more than just one budget line. Even when we do that though, NSF's own budget chart tells us that total agency STEM support will not increase in buying power. I worry about both the statement being made by the request and the consequences of flat funding for NSF's excellent programs.

Second, while I am supportive of NIST's efforts to catalyze the development of standards in emerging technology to address national priorities in cloud computing, health information technology, and smart grid, I want to ensure that those efforts are being appropriately coordinated with the regulatory agencies that are involved with these issues. If these efforts are to succeed, it is important that the other agencies respect the unique expertise of NIST in working with industry on standards development and that NIST's work be as responsive as it can be to the needs of other agencies.

With that, I again want to welcome our witnesses, and I look forward to working with Chairman Hall and our witnesses on all of these important issues, and I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you Chairman Hall and welcome to Dr. Suresh and Dr. Bowen who will be testifying before our Committee for the first time this morning. And welcome back to Dr. Gallagher who we'll hear from in our second panel.

The purpose of today's hearing is to examine the President's fiscal year 2012 budget request for the National Science Foundation and the National Institute of Standards and Technology—two agencies that are to key to our ability to spur innovation and improve STEM education in this country. I'm pleased to see that the President's budget request shares this Committee's goal, as reflected in the America COMPETES Act and the America COMPETES Reauthorization Act, of doubling the budgets of these agencies, and laying a strong foundation for our Nation's future competitiveness. This president understands that our future economic growth, and therefore our ability to reduce our debt in the future, is tied very strongly to the investments we make in science and innovation today.

In contrast, if the funding bill—H.R.1—passed by the House last month is enacted, we will be moving in exactly the wrong direction. I share the well- founded concern of many Members if we don't act to address our deficit, we will be leaving our children and grandchildren with a growing debt that they will spend their lifetimes trying to pay down. However, I am dumbfounded that we are even considering cutting the very investments that will reduce our debt over the long-term, ensure that there are well-paying jobs for future generations, and help our young people develop the skills that they need to get those jobs. The lasting consequences of the proposed cuts to science and education are enormous, and go well beyond the jobs and research facilities that would be lost today.

Fortunately the President, as evidenced by his Fiscal Year 2012 budget request, recognizes the importance of those investments. I look forward to hearing from Dr. Suresh and Dr. Bowen about some of the new research initiatives and directions being proposed by NSF in this budget as well as hearing from Dr. Gallagher about NIST's new initiatives.

Overall, I am quite happy with the requests. I am particularly pleased with the robust research budget being proposed by NSF and its efforts to provide opportunities to address critically important interdisciplinary research needs. I am also pleased to see that NIST's budget request includes sustained commitments to addressing critical challenges in manufacturing, clean energy, and cybersecurity.

That being said, I do have a couple of specific concerns. First, this Administration has made a strong commitment to STEM education, and I do not underestimate the impact of having the President himself publicly engaged on this critical issue. Once again, however, the Administration is proposing a budget for NSF's education directorate that barely keeps pace with inflation. I support an increased role for the Department of Education in STEM education and am happy to hear that collaboration between the agencies has increased significantly. Nevertheless, I think Chairman Hall will be with me when I say that this Committee will continue to stand up for the very important and unique role of NSF in STEM education. I understand that NSF funds education programs across the entire agency, so maybe we need to look at more than just one budget line. Even when we do that, though, NSF's own budget chart tells us that total agency STEM support will not increase in buying power. I worry about both the statement being made by the request and the consequences of flat funding for NSF's excellent programs.

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health information technology, and the smart grid, I want to ensure that those efforts are being appropriately coordinated with the regulatory agencies that are involved with these issues. If those efforts are to succeed, it is important that the other agencies respect the unique expertise of NIST in working with industry on standards development and that NIST's work be as responsive as it can be to the needs of the other agencies.

With that, I again want to welcome our witnesses. I look forward to working with Chairman Hall and our witnesses on all these important issues, and with that I yield back the balance of my time.

Chairman HALL. Thank you, Ms. Johnson. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point. And at this time, I would like to introduce our first panel of witnesses that we really appreciate. Dr. Subra Suresh is the Director of the National Science Foundation. Prior to his service at NSF, Dr. Suresh wore many hats at MIT, including Dean of Engineering. Dr. Ray Bowen is the Chairman of the National Science Board and President Emeritus of Texas A&M University, the one my daughter plans to attend if she can get in, with a faculty appointment in mechanical engineering.

This is the first appearance before this Committee for both of you in your current roles, and we welcome you and look forward to working with you. As our witnesses should know, spoken testimony is limited to five minutes. After which, the Members of the Committee will have five minutes each to ask questions. And I know Dr. Suresh and recognize you in just a moment, but I want to talk about the five minutes.

If we can stay as closely as we can to the five minutes to where those at the end of the line, and particularly our newest Members of Congress, get their chance to ask their questions. Just be considerate of everybody, Republicans and Democrats alike.

With that time, I thank you, Mr. Suresh, and I want to recognize you.

STATEMENT OF DR. SUBRA SURESH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. SURESH. Members of the Committee, it is my privilege to be here with you today to discuss the National Science Foundation's Fiscal Year 2012 Budget Request.

I came to the United States as a young engineering student because it was the world's beacon of excellence in science and engineering research and education. The mission of NSF is to sustain that excellence as we continue to lead the way for the important discoveries and cutting edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

The Fiscal Year 2012 Budget Request for NSF is $7.8 billion, an increase of 13 percent or $894 million over the Fiscal Year 2010 Enacted level. NSF's request is consistent with the President's Plan for Science and Innovation and with the *America COMPETES Reauthorization Act of 2010*.

America's economic prosperity and global competitiveness depend on innovation that comes from new knowledge, new technologies and a highly skilled and inclusive workforce. NSF has an unparalleled track record in supporting the best ideas and the most talented people for over 60 years. The Fiscal Year 2012 budget builds

on these past accomplishments and provides a direction for future success. NSF will strengthen support for basic research and education, the building blocks of future innovation, while strengthening our disciplinary excellence.

A new NSF-wide investment of $117 million will accelerate the progress of science and engineering through the deployment of comprehensive cyberinfrastructure. The cyberinfrastructure framework for the 21st Century Science and Engineering will explore ways to handle the vast quantities of data generated by today's cutting edge observational and computational tools, broaden access to cyberinfrastructure, and support community research networks.

Research at the interface of the biological, mathematical and physical sciences, a new $76 million investment, will explore nature's ability to network, communicate, and adapt and apply this understanding to engineer new technologies.

Today's most challenging research problems often bring together insights from across computer science, mathematics, and the physical life and social sciences. INSPIRE, new to the NSF's portfolio, is a $12 million investment to encourage investigators to undertake interdisciplinary research that is a hallmark of much contemporary science and engineering.

Many NSF activities provide incentives for investigators to undertake use-inspired research that translates basic discoveries into applications for the benefit of society and the economy. A $15 million investment in Enhancing Access to the radio spectrum will pursue innovative ways to use the Radio Spectrum more efficiently, enabling more applications and services used by individuals and businesses to occupy the limited amount of available spectrum.

Over the next five years, NSF will receive $1 billion from the Wireless Innovation Fund established with receipts from the spectrum auctions. NSF's support of advanced economics research led to the FCC's current system of spectrum auctions that have netted over $45 billion for the Federal Government since 1994. The Wireless Innovation Fund is expected to provide $150 million dollars to NSF in Fiscal Year 2012 for research on wireless testbeds and systems such as smart sensors for buildings, roads, and bridges.

Many fields are on the threshold of discoveries that can establish U.S. leadership in next generation technologies. In the 1960s and '70s, NSF support of mathematical process innovations lead the rapid prototyping and revolutionized manufacturing in the country.

The budget includes $190 million for a new advanced manufacturing initiative to pursue innovations in sensor and model-based smart manufacturing under the reinvestment of $30 million is allocated for the robotics initiative.

NSF will continue to play a lead role in multi-agency National Nanotechnology Initiative with an investment of $456 million. Over the past decade, NSF nanotechnology centers and networks created 175 startups and been in collaborations with over 1,200 companies.

U.S. leadership in science and engineering requires the most knowledgeable and skilled STEM workforce. Three new programs in STEM education, each funded at $20 million will improve teacher preparation, strengthen undergraduate STEM education, and broaden participation of underrepresented groups in the STEM workforce.

To conclude, OneNSF characterizes my vision for NSF as a model agency. NSF will work seamlessly across organizational and disciplinary boundaries to create new knowledge, stimulate discovery, address complex societal problems, and promote national prosperity.

Robust NSF investments in fundamental science and engineering have paid enormous dividends, improving the lives and livelihoods of generations of Americans. The Fiscal Year 2012 NSF Budget Request will carry this success into the future.

Mr. Chairman and Members of the Committee, this concludes my testimony.

[The prepared statement of Mr. Suresh follows:]

PREPARED STATEMENT OF DR. SUBRA SURESH

Chairman Hall, Ranking Member Johnson, and Members of the Committee, it is my privilege to be here with you today to discuss the National Science Foundation's fiscal year (FY) 2012 Budget Request. My name is Subra Suresh and I am Director of the National Science Foundation (NSF).

I hope to make a clear and compelling case for the critical value of NSF support for science and engineering research and education at a time when America faces many pressing needs and tight budget constraints. I came to the United States as a young engineering student because it was the world's beacon of excellence in science and engineering research and education. I stayed for the same reason. The mission of NSF is to sustain that excellence as we continue to lead the way for the important discoveries and cutting-edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

The President's request for NSF for FY 2012 is $7.8 billion, an increase of 13 percent, or $894 million, over the FY 2010 Enacted level. The President's Plan for Science and Innovation calls for doubling the federal investment in key basic research agencies. NSF's request is consistent with this plan, with the Administration's Innovation Strategy, and with the America COMPETES Reauthorization Act of 2010. The increase will support 2,000 more research awards across the nation.

In FY 2012, NSF will strengthen support for basic research and education in all fields of science and engineering, and promote collaborations that reflect the increasingly interdisciplinary nature of modern science and engineering, while strengthening our disciplinary excellence. We will capitalize on many promising areas of investigation where new discoveries can help establish U.S. leadership in next generation technologies, and we will invest in transformational work, new fields, and novel theoretical paradigms to fuel the innovations of the future. Innovative programs to bolster world-class science, technology, engineering, and mathematics education (STEM), from coast to coast, and from north to south, are central to the success of all these activities.

NSF: Where Discoveries Begin

Sustained federal support for research and education has fueled innovation and provided benefits to the American public for decades, and NSF has played a significant role in this success. For over 60 years, NSF has been a catalyst for the development of new ideas in science and engineering and supported the people who generate them.

In 1952, Caltech professor Max Delbruck used one of NSF's first grants to invent molecular biology techniques that enabled one of his students, James Watson, to determine the molecular structure of DNA. Since then, an entire biotechnology industry has bloomed and prospered, with profits reaching $3.7 billion last year.

In the 1960s and ,70s, NSF provided seminal funding for fundamental mathematical and process innovations for manufacturing that industry considered too risky to fund. These led directly to rapid prototyping-and revolutionized how products are designed and manufactured.

In the 1980s, NSF supported the very first computer science departments in U.S. universities, bringing computer science into the mainstream of research, and providing a training ground for the first and subsequent generations of computer scientists and entrepreneurs. Today, NSF provides 82 percent of total federal support for research in computer science conducted in the nation's universities and colleges. Jobs related to computer and information technologies are among the most rapidly growing in the nation according to Bureau of Labor Statistics projections.

In the 1990s, NSF supported pioneering research in the emerging field of nanotechnology. Between 2001 and 2010, NSF-supported centers and networks created 175 start-ups and developed collaborations with over 1,200 companies.

Investments in basic research often yield unexpected benefits as well. NSF's support of game theory, abstract auction theory, and experimental economics provided the Federal Communications Commission (FCC) with its current system for apportioning the airwaves. Since 1994, FCC "spectrum auctions" have netted over $45 billion in revenue for the federal government and more than $200 billion in worldwide revenue.

The NSF FY 2012 Budget Request builds on these past accomplishments and provides a direction for future success. To fuel the innovations of the future, NSF continues to support fundamental research and education in all fields of science and engineering to maintain a global edge in the competition for new ideas and the most talented people. The core science and engineering disciplines form the "building blocks" for future innovations, and provide the new ideas and approaches needed to advance the interdisciplinary research that is a hallmark of contemporary science and engineering. In all these activities, we keep a steady focus on the frontier, where discoveries begin.

The NSF FY 2012 Budget Request

The Administration's A Strategy for American Innovation makes clear the larger rationale for investments in science and engineering research and education. This is to put knowledge to work-to create the industries and jobs of the future, and to improve the quality of life and enhance the security and prosperity of every citizen. NSF investments support each of the three pillars of this strategy: Invest in the Building Blocks of American Innovation, Promote Market-Based Innovation, and Catalyze Breakthroughs for National Priorities.

Invest in the Building Blocks of American Innovation.

A robust U.S. science and engineering research enterprise is necessary to maintain a global edge in the competition for new ideas. In FY 2012, NSF will continue to support the most promising research programs and launch several new initiatives.

Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) will support new activities to encourage investigators to undertake the interdisciplinary research that is a hallmark of much contemporary science and engineering. This effort will be in concert with disciplinary excellence. INSPIRE will catalyze interdisciplinary research by seamlessly integrating a suite of new activities with existing efforts and other NSF investments. The goal is to foster and support the transformative research that interdisciplinary research so often produces. INSPIRE is a new $12 million initiative in FY 2012, and will involve participation from all Directorates.

Science and Engineering Beyond Moore's Law (SEMBL) explores next generation computing, including quantum computing, that addresses the limits of current technology. Those limits may be reached in as few as 10 to 20 years. In FY 2012, NSF will invest $96 million to continue this multidisciplinary program.

Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS) is a $76 million investment to investigate biological systems that provide architectural and operational blue prints which can guide engineering of adaptive technologies. BioMaPS will integrate research in the biological, engineering, mathematical, and physical sciences to better understand and replicate nature's ability to network, communicate, and adapt. The research will accelerate the generation of bio-based materials and sensors, and the advanced manufacturing of bio-inspired devices and platforms.

Global leadership also requires the most knowledgeable and skilled STEM workers in the world. NSF's approach is to develop the nation's talent pool by integrating research and education. This longstanding NSF practice facilitates the direct transfer of new knowledge to the private sector. It happens every time graduate students with experience working at the frontiers of discovery enter the work force. A strong suit in U.S. competitiveness, this is one of NSF's greatest contributions to the nation's innovation system. NSF will support three new initiatives to strengthen STEM education throughout the nation, and continue support for highly effective efforts to develop the nation's talent and workforce.

Teacher Learning for the Future (TLF), funded at $20 million, is a new teacher-training research program that will fund innovative efforts that design, develop, implement and test new teacher-training programs in cooperation with the Department of Education.

Widening Implementation and Demonstration of Evidence-based Reforms (WIDER), a new $20 million program to support research on how to achieve wide-

spread sustainable implementation of improved undergraduate instructional practices and student outcomes at major universities. Transforming Broadening Participation through STEM (TBPS), a third new program, will expand support for activities to broaden participation of underrepresented groups through partnerships that match research centers with other institutions committed to broadening participation. The FY 2012 investment in TBPS is $20 million.

The Faculty Early Career Development program (CAREER) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the excitement of research with inspired teaching and enthusiastic learning. In FY 2012, NSF will invest $222 million to support approximately 606 CAREER awards, an increase of 60 awards. The Graduate Research Fellowship program (GRF), funded at $198 million in FY 2012, supports the development of graduate students in order to cultivate the next generation of STEM workers. In FY 2012, NSF will award 2,000 new fellowships, sustaining the doubling of new fellowship awards achieved in FY 2010. In addition, the cost of education allowance will be increased from $10,500 to $12,000, the first increase in this level since 1998. The Budget Request also includes initial funding for a stipend increase to $32,000 that will be fully implemented in FY 2013.

Community college funding continues to be a priority for NSF in FY 2012. NSF engages community colleges through several programs, including Advanced Technological Education (ATE), Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES), the Louis Stokes Alliances for Minority Participation (LSAMP), and the Tribal Colleges and Universities Program (TCUP). The total investment in community college programs is $100 million.

Promote Competitive Markets that Spur Productive Entrepreneurship.

Advances in technology, economic growth, and a prosperous society depend on the translation of fundamental discoveries into new processes, practices, and commercial products that are widely used. Many NSF activities provide incentives for scientists, engineers, and educators to undertake use-inspired research that transforms basic discoveries into applications for the benefit of society and the economy.

The Advanced Manufacturing initiative will pursue advances in sensor and model-based smart manufacturing; cyber-physical systems such as advanced robotics; smart buildings and bridges; and nano-manufacturing. This initiative holds tremendous potential for significant short-term and long-term economic impact by developing the foundation for entirely new classes and families of products that were previously unattainable. The NSF request for FY 2012 includes $190 million for these activities.

The Wireless Innovation (WIN) Fund, a component of the Administration's new Wireless Innovation and Infrastructure Initiative (WI3), will provide $1 billion to NSF over the next five years. WI3 proposes to reallocate a total of 500 megahertz of federal agency and commercial spectrum bands over the next ten years to increase the Nation's access to wireless broadband. NSF will support research on experimental wireless technology testbeds, more flexible and efficient use of the radio spectrum, and cyber-physical systems such as wireless sensor networks for smart buildings, roads, and bridges. A portion of the receipts generated through electromagnetic spectrum auctions will provide funding for WIN. NSF's FY 2012 investments will be coordinated with a number of other agencies, including the Defense Advanced Research Projects Agency and the National Institute of Standards and Technology.

*Enhancing Access to the Radio Spectrum (EARS),*in addition to the related research funded through the WIN, will support research into new and innovative ways to use the radio spectrum more efficiently so that more applications and services used by individuals and businesses can occupy the limited amount of available spectrum. NSF proposes an investment of $15 million in FY 2012.

*Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (I/UCRC)*direct much of their basic research to problems with potential economic impact. By working closely with industry, these programs create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. They also prepare students for innovation leadership in a globally competitive marketplace. The FY 2012 NSF investment is $96 million.

*The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)*programs, funded at $147 million in FY 2012, build partnerships between the academic and industry sectors. They bolster the innovation economy by funding translational research at U.S. small businesses on topics that span the

breadth of NSF scientific and engineering research and reflect national and societal priorities.

Catalyze Breakthroughs for National Priorities.

In FY 2012, NSF will focus on key national priority areas, where the expertise of physical, biological, and social scientists and engineers can help advance U.S. goals through frontier research. NSF-catalyzed research includes investments in clean energy and the advancing fields of bio- and nanotechnology, areas that are poised for innovative breakthroughs.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is a new portfolio that builds on NSF's long history of providing leadership for cyberinfrastructure and computational science for the U.S. academic science and engineering community. The $117 million CIF21 will advance data-enabled science through the development of novel approaches to collect, manage, and curate the vast quantities of data generated by modern observational and computational tools. The program will also expand access to cyberinfrastructure to promote collaboration, and support improved community research networks to connect people, facilities, computers, and other tools.

The Science, Engineering, and Education for Sustainability (SEES) portfolio, funded at $998 million in FY 2012, draws together NSF programs that spark innovations for tomorrow's clean energy solutions. SEES will promote a cross-disciplinary approach to sustainability science to explore the environment-energy-economy nexus in order to inform energy and environmental policies and improve our capabilities for rapid response to extreme events, such as power grid disruption, floods, or extreme weather.

Clean Energy investments, a significant component of SEES, will lead to future clean energy and energy efficiency technologies. Investments totaling $576 million are found throughout the NSF portfolio, in core research programs and in activities such as BioMaPS and SEES.

The National Nanotechnology Signature Initiatives are promising research themes that have the potential to generate applications with widespread economic benefit, as well as address national and homeland security challenges. In FY 2012, NSF will invest $117 million in three research areas: Nanotechnology for Solar Energy Collection and Conversion, Sustainable Nanomanufacturing-Creating the Industries of the Future, and Nanoelectronics for 2020 and Beyond. NSF also supports advanced manufacturing research through these investments.

The National Robotics Initiative (NRI), a new interagency initiative for FY 2012, partners NSF with the National Aeronautics and Space Administration, National Institutes of Health, and the U.S. Department of Agriculture. NRI will marshal broad science and engineering support to provide U.S. leadership in the development of next generation robotics. The focus is on robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving. Collaboration and coordination strengthens the research effort and also ensures that agency programs do not overlap. NSF will invest $30 million in NRI in FY 2012.

Interagency Initiatives

NSF participates in a number of interagency programs that aim to coordinate research and development activities in areas of critical national importance.

National Nanotechnology Initiative (NNI), involving 25 departments and agencies across the federal government, focuses on realizing the tremendous potential of nanotechnology. Investments in nanotechnology have led to the discovery and development of entirely new classes of materials. NSF will increase support for NNI research by 10.6 percent to a total of $456 million. This investment includes the National Nanotechnology Signature Initiatives.

The Networking and Information Technology Research and Development (NITRD) explores new frontiers in computer, information, and networking science, and coordinates these efforts among multiple agencies. NSF will increase its investment in these activities by 15.3 percent to $1.258 billion in FY 2012. The focus of NSF support includes human-computer interaction and information management, high-end computing infrastructure and applications, large scale networking, and cybersecurity and information assurance. Other initiatives in the NSF budget will explore new techniques in education and workforce training to exploit cutting edge networking and information technologies.

Homeland Security Activities across NSF will increase by 9.2 percent to about $426 million. The focus is on two general areas: protecting critical infrastructure and key assets and defending against catastrophic threats. Approximately 73 per-

cent of this investment supports research in cybersecurity, emergency planning and response, and risk management, modeling, and simulation of resilient infrastructure.

Major Research Equipment and Facilities Construction

People and their ideas form the core of a robust science and engineering enterprise. But leading-edge tools are also needed in many cases to advance the frontiers and train students for the workplace. NSF provides the assets that will be central to success in the emerging "New Era of Observation," without precedent in terms of the sheer scale, scope, reach, resolution and volume of what we are able to observe. This new era has been enabled by the "Era of Data and Information" where we are now entering an emerging paradigm of data-enabled science.

NSF provides sophisticated tools to a broad population of scientists, engineers, students, and educators. All of the projects in the Major Research Equipment and Facilities Construction account undergo major cost and schedule reviews, as required by NSF guidelines. The following projects receive continued support.

- **The Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO)** is a planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO). AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection. The FY 2012 investment is $21 million.
- **The Advanced Technology Solar Telescope (ATST**) will enable study of the Sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that can affect communications and navigational satellites in space and power grids here on earth, and may influence climate. The FY 2012 investment is $10 million.
- **The Atacama Large Millimeter Array (ALMA)** is the world's most sensitive, highest resolution, millimeter wavelength telescope. ALMA will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The FY 2012 investment is $3 million.
- **The National Ecological Observatory Network (NEON)** will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. The FY 2012 investment is $88 million.
- **The Ocean Observatories Initiatives (OOI)** will provide continuous, interactive access to the ocean through a network of sensors designed to collect physical, chemical, geological, and biological data. OOI will produce never-before-seen views of the ocean's depths. The FY 2012 investment is $103 million.

Terminations/Reductions

NSF continually assesses its portfolio to ensure that investments align with agency priorities and focus on the frontiers of innovative science and engineering research. NSF proposes six programs for termination or reduction in FY 2012.

- **Deep Underground Science and Engineering Laboratory (DUSEL):** NSF eliminates funding for DUSEL. Termination is based on National Science Board reviews that concluded the cost and scope of DUSEL were inconsistent with the agency's traditional strengths and its role in advancing research and education across many fields and disciplines. NSF will continue to solicit proposals for future particle physics research. No funding is required in FY 2012 for DUSEL.
- **Graduate STEM Fellows in K-12 Education:** NSF eliminates the agency-wide Graduate STEM Fellows in K-12 Education (GK-12) program. While the program has been effective in meeting its overall goals, recent evaluation findings indicate that the effects of this program's fellowship experience in improving research skills is mixed, and program design limits the ability of participants to gain in-depth experience in K-12 teaching. NSF plans to build on experiences gained during the ten years of GK-12 funding to widen the breadth of graduate traineeship experiences through other programs.
- **National STEM Distributed Learning Program (NSDL):** NSF eliminates funding for the NSDL program (formerly the National STEM Digital Library). While NSDL has been successful in meeting its original goals, an October 2010 preliminary evaluation by the RAND Corporation, Steps Toward a Formative Evaluation of NSDL: Phase 2, noted the challenges of sustaining the collection in the face of changing technology, and raised concerns about

the currency of the collections, peer review of collections, collaboration across pathways, and lack of standardization. NSF plans to build from the substantial NSDL experience to address key areas in cyberlearning through other programs and activities, such as Cyberlearning Transforming Education (CTE). No funding is required in FY 2012 for NSDL.

- **Research Initiation Grants to Broaden Participation in Biology:** NSF eliminates funding for the Research Initiation Grants to Broaden Participation in Biology program (RIG) because it did not achieve the goal of broadening participation in biology. The number of proposals from underrepresented groups did not increase. RIG concludes in FY 2011.
- **Science of Learning Centers (SLC):** NSF proposes to reduce funding for the SLC program, which currently supports six large-scale, long-term centers that conduct science of learning research. The on-going center review process and reviews from an external May 2010 Advisory Committee both recommended that NSF phase the program down as funding for individual centers concludes and shift resources wherever possible to enhance support for the science of learning using non-center mechanisms. NSF expects there may be additional reductions to this program in future years as funding for individual centers comes to a close.
- **Synchrotron Radiation Center (SRC):** NSF eliminates funding for the Synchrotron Radiation Center facility at the University of Wisconsin. The SRC is 30 years old, and more powerful and capable facilities have come online since 1980.

Model Organization

The National Science Foundation aims to perform as a model organization in carrying forward its mission. Only six percent of the NSF annual budget is spent on management and administration. The FY 2012 request includes $494 million, an increase of $64 million, for activities to strengthen NSF's ability to manage its operations effectively and efficiently. These funds will support:

- Staff will include 40 additional full-time equivalents for a total of 1,365 FTE;
- IT investments of $86 million will include NSF financial system modernization (iTRAK), Research.gov expansion, and improvements to the operational IT system's reliability and security;
- Headquarters lease expiration funding is $45 million to plan and prepare for a new headquarters lease; and
- IAcquisition, part of the government-wide effort to strengthen the acquisition workforce and improve capabilities in the pre-solicitation phase of major acquisitions, receives $2 million.

NSF is committed to promoting strong, independent evaluation to inform its policy decisions, program management, and performance, and to sharing publicly available findings online.

OneNSF

The concept "OneNSF" characterizes NSF efforts to perform as a model agency. The National Science Foundation will work seamlessly across organizational and disciplinary boundaries to create new knowledge, stimulate discovery and address complex societal problems and promote national prosperity.

Within this overarching context, the process of setting NSF priorities involves many considerations and results in our best view of how to advance the nation's science, engineering, and education enterprise. Internally, NSF holds a series of retreats and planning meetings where directions are developed based on an understanding of new research frontiers, emerging fields, and opportunities to advance research and educational goals. NSF also considers opportunities to coordinate and collaborate with other agencies. Staff from all Directorates and Offices participate in these activities.

The NSF system of competitive merit review helps to bring the best ideas forward from every corner of the nation. NSF continues to accept and review unsolicited proposals, a practice that ensures that unanticipated and novel ideas of great promise are heard.

Conclusion

President Obama has spoken of this generation's new "Sputnik moment," a reference to the challenge of meeting the nation's economic and societal needs in the current climate of global competition for new ideas and talent. NSF's strategic investment in research and education will help the nation meet the challenges of our times and move beyond them.

Mr. Chairman and members of the Committee, I hope my testimony explains NSF's transformative role in building our nation's future prosperity and continued leadership at the frontiers of discovery, innovation and learning. Robust NSF investments in fundamental science and engineering have paid enormous dividends, improving the lives and livelihoods of generations of Americans. The FY 2012 NSF Budget Request supports leading edge programs and activities that will continue this success in the future.

This concludes my testimony. I thank you for your leadership, and will be pleased to answer any questions you may have.

BIOGRAPHY FOR DR. SUBRA SURESH

Dr. Subra Suresh, distinguished engineer and professor, was sworn in as the 13th director of the National Science Foundation (NSF) on October 18, 2010.

Dr. Suresh leads the only federal agency charged with advancing all fields of fundamental science and engineering research and education. He oversees the NSF's $7-billion budget, directing programs and initiatives that keep the United States at the forefront of science and engineering, empower future generations of scientists and engineers, foster economic growth and innovation, and improve the quality of life for all Americans.

Prior to his confirmation as NSF director, Suresh served as Dean of the Engineering School and Vannevar Bush Professor of Engineering at the Massachusetts Institute of Technology (MIT). He joined MIT's faculty ranks in 1993 as the R.P. Simmons Professor of Materials Science and Engineering. During his more than 30 years as a practicing engineer, he held joint faculty positions in four departments at MIT as well as appointments at the University of California at Berkeley, Lawrence Berkeley National Laboratory and Brown University.

A mechanical engineer interested in materials science and biology, Suresh pioneered research to understand the mechanical properties of materials. His most recent research tackled the biomechanics of red blood cells under the influence of diseases such as malaria. In 2006, Technology Review magazine selected Suresh's work on nanobiomechanics as one of the top 10 emerging technologies that "will have a significant impact on business, medicine or culture."

Holding true to his personal ideals, Suresh successfully leveraged his renowned research and leadership positions in academia to increase the number of women and minority engineers. He personally mentored more than 100 engineers and scientists in his research group. As department head and dean of engineering, he also led a successful campaign to increase the number of women among MIT's engineering faculty ranks.

The Padma Shri Award (2011) from the President of India, Indian Science Congress General President's Award (2011), Society of Engineering Science Eringen Medal (2008), European Materials Medal (2007) and Acta Materialia Gold Medal (2006) are among the many prestigious awards Suresh has received for his innovative research and commitment to improving engineering education around the world. He holds honorary doctorate degrees from Sweden's Royal Institute of Technology and Spain's Polytechnic University of Madrid. He has been elected a fellow or honorary fellow of all the major materials societies in the United States and India, including the American Society of Materials International, Materials Research Society, American Society of Mechanical Engineers, American Ceramic Society, the Indian Institute of Metals and the Materials Research Society of India.

Suresh has authored more than 230 research articles in international journals and is a co-inventor in more than 18 U.S. and international patent applications. He is author or co-author of several books that are widely used in materials science and engineering, including Fatigue of Materials and Thin Film Materials. He has consulted with more than 20 international corporations and research laboratories and

served as a member of several international advisory panels and non-profit groups.Suresh has been elected to the U.S. National Academy of Engineering, American Academy of Arts and Sciences, Spanish Royal Academy of Sciences, German National Academy of Sciences, Academy of Sciences of the Developing World, Indian National Academy of Engineering and Indian Academy of Sciences.

He earned his bachelor's degree from the Indian Institute of Technology in Madras in 1977; his master's from Iowa State University in 1979; and his doctorate from MIT in 1981. Suresh married his wife, Mary, in 1986, and they have two children, Nina and Meera.

Chairman HALL. Thank you, Dr. Suresh. I now recognize Dr. Bowen to present his testimony. Dr. Bowen.

STATEMENT OF RAY BOWEN, CHAIRMAN, NATIONAL SCIENCE BOARD

Dr. BOWEN. Chairman Hall, Ranking Member Johnson, and Members of the Committee, I appreciate the opportunity to testify before you today in support of the National Science Foundation budget request for Fiscal Year 2012. I am Ray Bowen, Chairman of the National Science Board and President Emeritus of Texas A&M University. I am especially pleased to appear before you today with our new NSF Director, Dr. Subra Suresh.

On behalf of the entire National Science Board, I would like to thank the Members of the Committee for the longstanding commitment in support of NSF and its investments and a broad portfolio research and education in science technology, engineering and mathematics, known to us as STEM.

NSF is a primary source of funding for academic basic research across non-biomedical science and engineering disciplines. During its 60-year plus history, NSF's broad portfolio of investments has underwritten a wealth of research and have directly and indirectly benefited the American economy and general public.

I would like to briefly touch on one what we think is the best known example of this feature. It is the development of the Internet. On the first Internet, the interconnection of unrelated networks was established by DARPA in 1977. NSF investments over the next decade lead to a system of networks managed by a mix of universities, nonprofit organizations, and governmental agencies. By the mid 1980s, primary financial support for the Internet had been assumed by NSF, and the increasing demand for advanced networking and research computing capabilities was met by what we call NSF Net.

By 1991, the NSF Net acceptable use policy was modified. It was modified to allow commercial traffic, and as the private commercial market grew, NSF decommissioned NSF Net. This was in 1995, allowing for public use of the Internet. Regional, national and international computer networks became widely accessible because companies began publicly offering gateway service.

This is just one example of many positive economic impacts flowing for NSF investments over the years. Due to its strong track record that the Board urges your strong support for the agency's FY 2012 budget request.

The NSF budget request reflects an understanding of investments of science and technology that are critical to building America's future. This requesting knowledge is the importance of science and technology to America's long-term economic growth.

One specific area I would like to mention is the Foundation's Agency Operations and Award Management accounts, so-called AOAM account. This account provides the framework through which the foundation of science and engineering research and education programs are administered. The agency operation award management funding covers NSF's scientific, professional, and administrative workforce, the physical and technological infrastructure and the essential business operations critical to providing a high quality of customer service to the public.

With the AOAM account comprising only four percent of the agency's budget request, NSF has achieved an impressive state of administrative efficiency. The Fiscal Year 2012 request for AOAM aims to ensure that the agency will remain a model organization. The Board urges full funding of NSF's Operation and Awards Management account.

I would like to describe, briefly describe, the Board's role in the development of the agency's budget request. The Board's Committee on Strategy and Budgets, the CSB committee, has primary responsibility for working with the NSF during the budget development phase, leading up to the Board's approval of the budget submitted to OMB. CSB has several discussions both by telephone and face-to-face meetings with the NSF national budget development during the course of the year. These discussions include priorities established by the administration articulated in the Office of Management and Budget and the Office of Scientific and Technology Policy research and development memo, a memo which emphasizes coordination across agencies of common goals in science and engineering activities.

Programs and research areas of interest such as those emphasized in reauthorization bills and those articulated in congressionally mandated reports from the National Academy of Sciences are also part of these deliberations. In addition, there is a continual engagement of relevant STEM communities across the Nation. Further involvement with the science and engineering community includes NSF's advisory committee meetings, which are held throughout the year.

These committees, constituted through the *Federal Advisory Committee Act*, provides strong strategic input to each of the agency's Directorates, especially with regard to envisioning science at the horizon. The budget process and priority setting are on the minds of these groups, which openly share the needs of their respective communities.

Development of each year's budget request is somewhat a unique process. It is very interactive. There is no set formula. Considerations include the potential for impact, the readiness of the community, and the ability of programs to leverage activities with other resources.

In the end, we believe a continual assessment and reassessment of priorities brings the best budget forward for the Foundation and for the Nation. We understand that investments in science and technology compete with a host of other worthy priorities. While it might be tempting to forego the long-term investment in the face of these near-term challenges, neglecting scientific research and

education now may have serious consequences for the future of our country.

I respectfully ask that you bear in mind something that you all realize, that investments in our scientific and technological workforce, infrastructure and basic research are critical for long-term prosperity and security. This critical need for investment is best demonstrated in the recent report of the National Academies, "Rising Above the Gathering Storm," a report which received bipartisan acclaim.

On behalf of the National Science Board and the STEM research and education communities, I would like to end by again thanking the Members of the Committee for your long-term recognition of the National Science Foundation and your commitment to this agency. We look forward to our continuing productive working relationship, and that completes my testimony.

[The prepared statement of Dr. Bowen follows:]

PREPARED STATEMENT OF DR. RAY M. BOWEN

Chairman Hall, Ranking Member Johnson, and Members of the Committee, I appreciate the opportunity to testify before you today in support of the National Science Foundation's budget request for Fiscal Year 2012. I am Ray Bowen, Chairman of the National Science Board (Board) and President Emeritus of Texas A&M University. In 2002, I was nominated to the Board by President Bush, confirmed by the Senate, and then renominated and confirmed in 2008. I was elected Chairman of the Board by my peers in May 2010. In my experience with the Board during these past nine years, I have been consistently impressed with the quality of research supported, the long reach of National Science Foundation (NSF) activities, and by the dedication and expertise of the agency's staff.

Introduction

On behalf of the entire Board, I would like to thank the Members of this Committee for your long-standing commitment to support of the NSF and its investments in a broad portfolio of research and education in science, technology, engineering, and mathematics (STEM). NSF is the primary source of funding for academic basic research across non-biomedical science and engineering (S&E) disciplines. NSF funds cutting-edge research at the frontiers of knowledge, and also supports scientific facilities and activities in STEM education. During its 60-year plus history, NSF's broad portfolio of investments have underwritten a wealth of research that have directly and indirectly benefited the American economy and the general public. In light of the many achievements garnered from previous investments in S&E research, the Board urges your strong support for the agency's fiscal year 2012 budget request.

The context for our fervent support for NSF's budget request may be best appreciated within the context of the history of Federal support for basic scientific research. During WWII, Dr. Vannevar Bush led the Office of Scientific Research and Development, and with the strong backing of President Roosevelt, he organized and provided Federal funding for hundreds of research projects in university and industrial laboratories to support the war-time effort. The success of this endeavor precipitated a profound reassessment of the Federal role in national research.

In 1945, Bush published Science-The Endless Frontier, which was a treatise on the need for the Federal government to provide regular, peace-time support for both basic research at universities and the education of future scientists through a single new agency. Bush wrote: "The Government should accept new responsibilities for promoting the flow of new scientific knowledge and the development of scientific talent of our youth. These responsibilities are the proper concern of the Government for they vitally affect our health, our jobs, and our national security." Importantly, he noted that "basic research is essentially noncommercial in nature. It will not receive the attention it requires if left to industry." The Bush vision encouraged the mission agencies to support research universities in fields that were deemed to have probable long-term relevance to their missions.

Five years later, in 1950, the National Science Foundation was created. Federal support for science research was encouraged, and with it, unprecedented innovation in the scientific and technological arenas. Due in large part to NSF's support for S&E research and education, our research universities have become the envy of the

world. The application of new knowledge and human capital development in STEM fields resulting from this Federal/academic partnership has indeed created handsome benefits for all Americans. These long-term and often uncertain investments in S&E research and education over a half-century have provided extraordinary dividends for successive generations of our citizens.

In the presence of global competition, our Nation should be strong in all facets of technical innovation and should have available a continuously renewed base of knowledge to inform its decisions and those of its citizens. In order to prosper over the long term, a nation requires several essential building blocks of innovation, including a robust high-tech industry, a well-educated scientific talent base, and a vigorous research community.

Although the Board is very cognizant of the current Federal fiscal constraints that our Nation faces, we are also certain that the unique and long-term value of NSF programs in science and engineering research and education foster the bedrock of our future economic health. This long-term value is the basis of the Board's support for the Foundation's FY 2012 Budget Request.

Concern about U.S. Leadership in S&E

A recurring concern of the Board is the potential loss of U.S. global leadership across the science and engineering spectrum. As many other countries invest heavily in science and engineering research, graduate a record number of scientists and engineers, and increase incentives to attract outstanding international students and scholars, it would be unwise for the U.S. to neglect our science and engineering enterprise.

The United States has long been a leading center of science, technology, and innovation, but we now face challenges as a result of growing capacity in science and technology (S&T) across the globe. Economists increasingly emphasize the central role of knowledge, particularly R&D and other activities to promote science and technology, in a country's economic success. But as recent indicators show us, in our biennial statistical report, Science and Engineering Indicators 2010 (SEI 2010), many countries and economies have taken steps to open their markets to trade and foreign investment, develop or recast their S&T infrastructures, stimulate industrial research and development (R&D), expand their higher education systems, and build indigenous R&D capabilities. In short, they are developing strategic plans and policy frameworks for increasing S&T capacity, and investing in the requisite infrastructure and workforce to achieve their objectives.

The current status of the Nation's economy makes it imperative that we do not lose ground in the global S&E race. While the United States still leads the world in R&D investments, other countries have continued to increase R&D expenditures at an expanding rate. For example, between 1996 and 2007, China increased its R&D expenditures at a 20 percent annual growth rate. Increased global R&D activity should by no means be viewed as negative. It leads to a dynamic global system of exchange of scientific knowledge and collaboration among diverse researchers, and provides opportunities to build shared international facilities. However, the United States must view increased global capacity in S&T as a call to sustained action to continue robust investments in science and technology.

One of the key returns on investment in science and engineering is the creation of new jobs. The S&E workforce has shown sustained growth for over half a century, and growth is projected to continue into the future. The number of workers in S&E occupations grew from about 182,000 in 1950 to 5.5 million in 2007. This represents an average annual growth rate of 6.2%, nearly 4 times the growth rate for the total workforce.

If innovation in the form of new technologies, goods and services are imported from other countries, our national competitiveness will be affected. The distribution of R&D funds by the U.S. is a direct reflection of our dedication to lead the world in S&E, and it provides insight into the Nation's broad mission priorities. Outcomes and benefits of R&D depend heavily on the total resources devoted to it.

Board Role in Development of the NSF FY 2012 Budget Request

The NSF budget request for Fiscal Year 2012 reflects a clear understanding that investments in science and technology are critical investments that will build America's future. This request acknowledges the critical nature of science and technology to America's long-term economic growth. Federal support for research and education across S&E fields is of special importance in uncertain economic times, especially when private firms are hesitant to invest in long-term research and development projects.

For the past 60 years, the National Science Foundation has played a central role in innovation by catalyzing the development of fundamental ideas across the frontiers of science and engineering knowledge and supporting the people who generate them. As the only federal agency dedicated to the support of basic research and edu-

cation in all fields of science and engineering, NSF is positioned to strategically stimulate innovative research that connects the science and engineering enterprise with potential economic, societal, and educational benefits. NSF's high-risk, potentially transformative investments will continue to lead the way for the important discoveries, the education of the future science and engineering innovators, and cutting-edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

The Board is intimately engaged with the development of the agency's initiatives featured in its budget request. The Board, primarily through its Committee on Strategy and Budget, with NSF senior leadership participates in the development of the budget from the initial planning stage for the next budget through informal discussions, numerous teleconferences, and final approval of the submission to OMB. In working with the agency on determining priorities, we take into account the priorities of the Administration and Congress. We also bring our experience with the needs and readiness of the Nation's science and engineering community as a whole. NSF FY 2012 Budget Request

The Board supports the FY 2012 Budget Request in its entirety. We are especially supportive of those programs that reach across disciplines to bring fresh approaches from differing perspectives to tackle some of the greatest challenges of our time. Throughout its history of developing successful collaborations with researchers in many disciplines, NSF is in the best position to bring together the science community to address seemingly intractable problems or controversial ideas at the frontiers of knowledge. The details of these efforts are best left to Dr. Suresh and the agency's senior management to describe.

For the budget request before you today, one specific area I would like to focus on is the Foundation's Agency Operations and Award Management (AOAM) account.

The AOAM account provides the fundamental framework through which the Foundation's science and engineering research and education programs are administered. AOAM funding covers NSF's scientific, professional, and administrative workforce; the physical and technological infrastructure necessary for a productive, safe and secure work environment; and the essential business operations critical to managing NSF's administrative processes and providing high-quality customer service to the public.

The quality of the merit review process greatly depends upon NSF professional staff with the necessary expertise, within and across disciplines, to select and recruit superior reviewers and panelists, and the outstanding administrative staff to support them. The need for first-class scientific review is very high as just in the last year, NSF staff directed reviews of over 55,000 proposals. Each was thoroughly examined to ensure only the highest quality research would be supported. To sustain this excellence in merit review, the Board urges full funding for NSF's AOAM account.

For the National Science Board Office, the Board requests $4.84 million, an increase of $340,000, or 6.6 percent, for FY 2012. This proposed increase will allow the Board to continue to strengthen its national and NSF policy role and in oversight for NSF.

NSB Oversight Role

When Congress established the National Science Foundation in 1950, it defined dual responsibilities for the National Science Board. First, the Board was to oversee the activities of, and establish the policies for, the National Science Foundation. Second, the Board was to serve as an advisory body to the President and Congress on national policy issues related to science and engineering and education in science and engineering. For today's testimony, I'd like to focus on our first responsibility, that of oversight of NSF.

Merit Review

As you all know, NSF-funded research and education projects are selected through competitive, merit-based review. This is often cited as the 'gold standard' for funding research, and is emulated by many countries as they develop and enhance their own scientific research efforts. Expert panels rely on two criteria to evaluate proposals: intellectual merit and broader impacts. Every year, the Board reviews the outcomes of the agency's merit review process. In the latest report (for FY 2009), NSF made nearly 10,000 awards with Omnibus funding. An additional 4,620 awards were supported with the $3 billion of American Recovery and Reinvestment Act (ARRA) funding. With the ARRA funding, NSF reached a 32 percent funding rate in FY 2009, significantly exceeding the 25 percent funding rate in the previous year.

A large number of meritorious proposals are declined each year. Every year, NSF must decline highly rated scientific proposals due to budget limitations. For FY 2009, approximately $1.3 billion in added funding could have supported the many

proposals that merited awards. This represents a substantial lost opportunity in terms of both innovation and job creation.

MREFC

The National Science Board has statutory responsibility for the oversight of activities funded from the Major Research Equipment and Facilities Construction (MREFC) account. These are high profile, high cost activities that are unique, meaning that they must often be designed and developed without a template. In my time on the Board, the agency has made great strides in overseeing both the design and construction of these critical facilities. It is a substantial challenge to prioritize and manage MREFCs, and the Board invests substantial efforts to review scientific needs, construction costs, and operations and maintenance costs in the MREFC process. (URL for the process or attach the document)

Future operating costs for facilities are considered when the Board decides whether to approve construction of a new facility under the MREFC account. Projects are repeatedly assessed throughout the planning and construction period to ensure accurate awareness of projected operating costs. Beginning with the NSF FY 2009 budget request, the NSF Director instituted a "no cost overrun" policy requiring that the project cost estimate include adequate contingency funds to cover all foreseeable risks, and that any cost increases not covered by contingency be accommodated by scope reduction. Since implementing the policy for new facilities, NSF has been successful at staying within cost and schedule plans.

In FY 2012, NSF will continue construction of five MREFC account projects: Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO), the Advanced Technology Solar Telescope (ATST), the Atacama Large Millimeter Array (ALMA), National Ecological Observatory Network (NEON), and the Ocean Observatories Initiative (OOI). All five MREFC projects in the 2012 Request have been reviewed and recommended for funding by the Board. The Board continues to work with agency senior management to improve the process for selecting and managing the MREFC account.

NSF Strategic Plan for FY 2011-FY 2016

NSF senior management worked closely with the Board in developing its new strategic plan. The plan, "Empowering the Nation through Discovery and Innovation," establishes an overarching vision for NSF's role in the Nation's innovation enterprise, challenging the agency to set its sights high. The three major goals outlined in the strategic plan emphasize the unique role of the agency. The first goal, Transform the Frontiers, embraces support for the fundamental, interdisciplinary, high-risk, and transformative research and education that NSF has pioneered. The second goal, Innovate for Society, links the results of fundamental research to national and global policy areas where science and engineering play a significant role. The final goal, Perform as a Model Organization, sets high standards for attaining excellence in operational activities, promotes a culture of integrity and accountability, and encourages new approaches to assessment and evaluation of NSF's investment portfolio.

The America COMPETES Act

The 2007 reauthorization of NSF, commonly referred to as the *America COMPETES Act*, recognized the critical role the agency plays in maintaining the Nation at the forefront of research. With COMPETES, Congress recognized that the Federal Government must increase its investment in basic research and in science and math education, stating as the purpose of the Act "to invest in innovation through research and development, to improve the competitiveness of the United States and for other purposes." On behalf of the National Science Board, I want to reiterate the key role that science advancement plays in furthering the Nation's economic base. The Board intends to continue its oversight of NSF awards to ensure the national treasure is invested productively.

The America COMPETES Reauthorization Act of 2010 requires the Board to report to Congress on the mid-scale instrumentation needs of the science and engineering communities. The Subcommittee on Facilities is in the process of collecting background data and consulting with experts throughout the Nation's science and engineering community about future instrumentation needs. The report is due in January 2012, and NSB expects to submit its final report by that time.

ARRA

The National Science Board has taken particular interest in overseeing the $3 billion provided to the agency in the 2009 American Recovery and Reinvestment Act (ARRA, stimulus). The stimulus funding represented nearly 50 percent of the agency's annual budget, and the Board, acting in its oversight capacity for the agency, endeavored to ensure the additional funds were well spent.

NSF management set up an overall framework for ARRA investments which emphasized sustainability and innovation. Management determined that grants would

be allocated with varying durations. This would allow the agency to structure a sustainable portfolio with requests for renewal of projects staggered through the years. To encourage innovation, NSF management prioritized the funding of new principal investigators and funding of high-risk, high-return research. Because NSF has a large number of highly rated proposals that it is unable to fund, the agency used the majority of the funding to support those meritorious proposals which had already had been submitted, reviewed, and found to be deserving of funding, though available funds were insufficient to support them until ARRA funds were made available.

For every Board meeting since ARRA was enacted, NSF has provided detailed updates on its disposition of this special category of funding. NSF skillfully managed this new responsibility, making timely awards in concert with the law's requirements. Funds had to be distributed quickly to meet the intent of the stimulus, and NSF was one of the most successful agencies in meeting this goal. In addition, stringent reporting requirements from the awardees was another mandate of the stimulus, and NSF, working closely with the community, developed a robust reporting process that has seen more than 99 percent of awardees submit their results on time.

Closing remarks

As our Nation recovers from economic recession, investments in science and engineering research and education are ever more critical to laying the long-term foundation for S&T-based innovation that drives the creation of new jobs and industries. The economic growth and the quality of life that we enjoyed in the 20th century were made possible in large part by scientific discoveries and technological innovations. Continued economic prosperity will require continued Federal investments in science and engineering research and education.

Investments in science and technology compete with a host of other funding priorities. Though it might be tempting to forego the long-term investments in the face of short-term challenges, neglecting scientific research and education now will have serious consequences for the future of our country. As other countries now actively seek to emulate our success by building their own innovation infrastructures, we must be ever vigilant to enhance our own innovative capacity.

This is a difficult time for Federal budgets for S&E research and education and the institutions and individuals in the nonprofit and public sectors that rely on Federal support. The Federal government has sustained a continual, visionary investment in the U.S. research and education enterprise in the expectation that such investment would benefit all Americans. That Federal effort has expanded the horizon of science and engineering discovery and achievements far and wide, leading to the realization of enormous benefits to our Nation.

In recognition of our current Federal fiscal realities, the National Science Board will ensure that NSF sets priorities, makes hard programmatic budget decisions and, as a result, obtains the greatest benefit from the funds provided. However, even in a time of budget constraints, as a Nation we cannot ignore our growing dependence as a society on innovation for economic prosperity and the ever-improving quality of life Americans have come to expect. The Federal compact in research and education with the nonprofit sectors is an essential pillar of our Nation's global dominance in S&T.

On behalf of the National Science Board and the S&E research and education communities, I would like to thank the Members of the Committee for your long-term recognition of and commitment to support for the National Science Foundation. We look forward to continuing our productive working relationship with you in service to the Nation.

BIOGRAPHY FOR DR. RAY M. BOWEN

Ray M. Bowen was born in Fort Worth, Texas, and earned his B.S. in mechanical engineering at Texas A&M University. After receiving his M.S. at the California Institute of Technology, he returned to Texas A&M for his Ph.D. in mechanical engineering. From 1994 to 2002, he served as president of Texas A&M and is currently president emeritus with a faculty appointment in mechanical engineering. His research interest is in nonlinear continuum mechanics. He teaches in the Department of Mathematics as well as in the Department of Mechanical Engineering at Texas A&M.

Under Bowen's leadership, Texas A&M was admitted to the Association of American Universities, expanded and enhanced numerous academic programs, and successfully completed a major capital campaign. Bowen has been instrumental in the creation of Vision 2020, an effort to propel the institution into the ranks of the country's top ten public universities by the year 2020.

Before assuming the presidency of Texas A&M, Bowen served for a year as interim president of Oklahoma State University. He joined the administration of Oklahoma State in 1991 as provost and vice president for academic affairs. His earlier academic appointments included Dean of the College of Engineering, Director of the Center for robotics and Manufacturing Systems, and Director of the Center for Applied Energy Research at the University of Kentucky (1983-1989); faculty member in the Mechanical Engineering and Mathematical Sciences Department, Rice University (1967-1983); and member of the engineering mechanics faculty at Louisiana State University (1965-1967).

Bowen held two managerial positions at the National Science Foundation. In 1982-1983, he served as Director of the Division of Mechanical Engineering and Applied Mechanics, and in 1990-1991, he was Deputy Assistant Director and Acting Assistant Director for Engineering. He is a member of several professional societies and has authored or coauthored numerous professional articles and books.

Bowen was appointed to the National Science Board in 2002 and reappointed in 2008. He was elected Chairman in 2010.

Chairman HALL. Thank you, Dr. Bowen and Dr. Suresh, for your testimony, and once again, I will remind all of us that the committee rules limit us to five minutes, and we have two distinguished panels before us today. I will open by recognizing myself for 4 minutes and 59 seconds.

Dr. Suresh and Dr. Bowen, I will ask both of you this question. NSF received $3 billion in stimulus or *American Recovery and Reinvestment Act* funding. Could you please give us an update on the NSF investment, particularly how many jobs were created? Has all the money been spent? If not, why not? And if so, were any significant scientific breakthroughs realized, or is it still too early to tell? You can't hardly answer that with a yes or no, so we will start out with how many jobs were created if you have that information.

Dr. SURESH. Mr. Chairman, NSF last year received 55,000 proposals, of which we funded 13,000. NSF receives far more out-

standing proposals than we are able to fund in the community. When the ARRA funding became available to the tune of $3 billion a few years ago, we were able to very quickly allocate those funds to truly outstanding proposals that were peer reviewed based on our very well-established criteria. So with respect to your question, all of the funding has been very efficiently allocated to the community.

NSF takes a long-term view on basic research, even though oftentimes we have many short-term benefits. The funds that we have allocated have only been out there for one to two years, so it will be too early and somewhat premature for us to assess how many jobs have been created.

But let me just point to one reason, a set of data, that addresses your question. NSF was a pioneer in the new creation of the National Nanotechnology Initiative that came into existence in 1999. In just 11 years, NSF-funded centers, created 175 startups that involved 1,200 companies around the country, involving thousands of jobs. So based on that and based on other data that we know from the past, it is our every expectation that this investment in scientific discovery will lead to substantial payoffs in the mid-term and the long-term for the country.

Chairman HALL. Do you agree with the $3 billion that you received, has all the money been spent?

Dr. SURESH. All the money has been committed.

Chairman HALL. Or committed.

Dr. SURESH. Yes.

Chairman HALL. Yeah, okay. And, Dr. Bowen, would that be your answer too probably pretty close?

Mr. BOWEN. Yes, sir, all the money has been committed. We are quite proud of the Foundation and staff for the effective way they have utilized this money, and I think the long-term payoffs will be something we will celebrate before this Committee sometime in the future.

Chairman HALL. On the grants, Dr. Suresh, were they new jobs, or were they additional funding for existing jobs?

Dr. SURESH. So the 13,000—every year we—our typical grant goes for about three years or so. So typically one-third of the funding that we have goes for new funding, and the typical grant size is about $150,000 per year, and it goes for three years. So we have a process whereby we not only review proposals every year, but we also look at how funded proposals perform. We have annual reviews, grantee conferences when we periodically ask the performance of the grantee.

Chairman HALL. Thank you. And do either of you have any significant scientific breakthroughs realized, or is it too early to tell, or do you either care to comment on that?

Dr. SURESH. Well, we have lots and lots of scientific discoveries that evolve every year. Just—I can go back to the long-term one, and I can tell you the short-term one. Our Social, Behavioral, and Economic Sciences directorate funded research on communities networking for the benefit of interactions with respect to resources, natural resources that are available through Dr. Elinor Ostrom, from the University of Indiana, and that led to a Nobel Prize in 2009. We have discoveries in nanotechnology all across the founda-

tion, especially in engineering, math, and physical sciences, and the computer and information sciences and engineering that are revolutionizing computer industry and creating new jobs.

Chairman HALL. Okay, thank you very much. My time is up. At this time, I recognize Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman. Dr. Suresh, in December Congress reauthorized and passed the America COMPETES, and I know that it has been quite recent. Three years ago, of course, we passed the first America COMPETES, and it really was in direct response to "Rising Above the Gathering Storm." We realize we are in the midst of the storm now.

But can you give us any update yet on whether or not it has had any impact?

Dr. SURESH. I think that it has galvanized the community and brought to focus the pressures that are on us, not only with respect to the continued need to support science and engineering in the country, but the increasing global competition for science and engineering, for innovation, and for the workforce.

One example that I can give with a lot of data points and personal experience is when I came to the United States in 1977, there was no question for me, as a young 21-year-old engineering graduate, as to where I wanted to go in the world. And I came here, as did many of my colleagues, fellow graduates. Today there is competition from all over the world, and I think if—and that competition is increasing. It is increasing significantly. Other countries with a large population are investing hugely into science and engineering and scientific infrastructure.

And therefore I think—and that is why the second report put out by the National Academies is entitled Category Five—even though there has been a significant impact of the first report, there is continued belief in the community that we are reaching a crisis stage still, even with the investment. And therefore we cannot take the eye off the ball.

Ms. JOHNSON. Thank you. Women continue to go down in their numbers in entering these fields, and I did put an amendment on the original bill before it went to the Senate that contained a study to involve more women. I have now introduced it as an independent bill as I have done before, but are there efforts going on to attempt to increase women's and even minority and handicapped participation? Because we need all we can get, and we are not seeing that much of an increase.

Dr. SURESH. Thank you for asking this question. As you know, Ms. Johnson, when you and I met recently, this is a topic that is not only of great importance to NSF and has been a topic that NSF has played a leading role over the last decade or so. I have a personal commitment to this topic. Let me give you some brief remarks related to your point. With respect to women in the engineering workforce, NSF supports it in many different ways.

We introduced an ADVANCE program some years ago, which is having a huge impact in the community. Our support for graduate research fellowships has gone up. Forty percent of the graduate research fellows last year are women graduates. We have some encouraging news with respect to women coming into the workforce. For example, the most recent year for which we have data, 2009,

72 percent of the valedictorians in American high schools were girls, and their fraction is increasing. In 2009, 20 percent more women graduated from college than men did, and that difference is increasing.

In the last 20 years in the United States, there was a ten percent increase in the number of Ph.D.s given to science and engineering graduates. That entire ten percent increase was because of women receiving Ph.D.s in science and engineering. So this is all good news with respect to women in the workforce. And NSF supports women through a CAREER award, and this year in the Fiscal Year 2012 budget, we have a request for an increase of 60 percent or about a little more than 10 percent—60 CAREER awards or a little more than ten percent for supporting all candidates, including women candidates.

But here is the problem. The retention of these women in the workforce has been an issue. The most recent year for which we have data is 2006, and women comprise only 26 percent of the STEM workforce, so there is a lot that needs to be done with respect to retention even though their entry into the process has seen some very good news. And this is something that we have discussed internally. There are a number of mechanisms that we will introduce using existing programs that will go in the right direction.

Ms. JOHNSON. Thank you very much. My time is about up, but it appears to me that we are still attempting to be where we are supposed to be with only 50 percent of our brain power.

Chairman HALL. Thank you, Ms. Johnson. On behalf of Dr. Brown here and the other male Members of this, could I have a copy of your amendment? You said 70 percent increase? Will you give me a copy to introduce.

Ms. JOHNSON. Okay.

Chairman HALL. Alright, thank you. Alright, at this time, I recognize Mr. Rohrabacher, the gentleman from California.

Mr. ROHRABACHER. Thank you very much. Let me just—thank you everybody in your organization. Your—the work you do is so important for our country, and perhaps that is one of the reasons why we have to pay attention to make sure the money is being channeled in the right direction. We are talking about $7.8 billion budget. Is that correct? And that represents a 13 percent increase over last year's budget.

Dr. SURESH. Over the 2010 enacted level.

Mr. ROHRABACHER. Okay, is the $3 billion stimulus, that is 13 percent over and above the $3 billion in stimulus or not? Is that included in this?

Dr. SURESH. No, the stimulus funding has expired. It has already been committed. It is a one-time funding.

Mr. ROHRABACHER. Right.

Dr. SURESH. The $3 billion.

Mr. ROHRABACHER. Sure.

Dr. SURESH. So that is not in this.

Mr. ROHRABACHER. So you went through $3 billion within a year or 18 months in terms of committing it when your usual budget would be $7.8 billion? Is that correct?

Dr. SURESH. That is correct.

Mr. ROHRABACHER. Okay, so you would suggest to us that a $3 billion increase in your spending level that you are capable, that you guys are capable of actually expanding that much? I mean that is a dramatic expansion of spending in a one-year or two-year period. And you are able to do that and put the taxpayers' money to good use?

Dr. SURESH. Well, that is an excellent question, Mr. Rohrabacher, and I cannot only claim that we are capable of spending it. We have demonstrated that we are capable of spending it, but for the following reason. We funded between 10 and 12 percent of the actual number of proposals that come to us. We fund only a small fraction of the outstanding proposals that are out there from the community.

Mr. ROHRABACHER. So what you obviously did then was take the proposals that had been rejected when you had less money and had to make a more, let us say, fine-tuned decision as to where that money was going to go. And you have received more money, and you were just able to use those things that had been rejected in the years before because you didn't have all the money?

Dr. SURESH. Not all of the funding, if I may add a point. We also funded a variety of programs because of the availability of money that we could not have funded——

Mr. ROHRABACHER. Right, well I am just suggesting that when you had to prioritize, you didn't fund certain things that as soon as we gave you the stimulus money, they were funded. Let me ask you about one specific item here and what this represents. I noticed that there has been a $171,000 grant to a New York theater company for a climate change play. Now, if we were talking to the National Endowment for the Arts, maybe this would be a different level of discussion. What is your organization doing financing plays, theater plays?

Dr. SURESH. So I——

Mr. ROHRABACHER. Especially ones that are aimed at basically presenting a point of view on a vision of climate change, which should be very serious rather than propagandistic.

Dr. SURESH. So let me add a few points. I have not seen the play, so I don't know the contents of this in the interest of full disclosure. NSF not only engages in funding science, but also in engaging science for the public, disseminating the information from science to the public. That is point one.

The second point is NSF does not engage in advocacy. We don't—we just present the facts. We just present the scientific data. The community makes up its mind on that.

Mr. ROHRABACHER. Let me note that. The description of this play, certainly it is an advocacy play, and I would suggest you take a very close look at that and do not repeat that and come back to us to expect to take your opinion seriously if you are funding this type of nonsense. And the bottom line is that we—yeah, it is science for the public. That could well be said that, yeah, we are going to propagandize people on points of view if we get into controversial areas.

Your job, and what you have done well and what we all applaud, is when you are expanding the horizon of scientific knowledge in this country so that it can be utilized to uplift humankind, we don't

necessarily need a leader of discussion among the public on various issues, whether they deal with morality or whether they deal with climate change. So with that said, I would hope that you pay a little more attention to things like this so that we don't have to bring it up to you in hearings next year when you come before us.

Because I know you will have done—nine out of ten things you are doing this year will be wonderful and that we can support. And unfortunately at the hearings, quite often we are only looking at those things where we disagree. So let me just—I am not trying to ignore the good things, but we have to bring up these things as well.

Chairman HALL. Thank you. The gentleman's time has expired. Ms. Lofgren, the young lady from California.

Ms. LOFGREN. Well, thank you very much, Mr. Chairman, and thanks to the two of you for being here today to testify to us, but beyond that, your service to our country at the NSF. It is outstanding, and it is appreciated.

You know I come from Silicon Valley, and we know that when times are tough, it is time to double down on science funding, and that is a broadly supported proposition in the valley, not only among scientists, but you can go out among working people who understand that prosperity is very much tied to what we do in science and innovation. So I am interested, Dr. Bowen, in your take on the C.R. H.R. 1 that was recently passed and we are still trying to come to grips with the ongoing funding.

I received a letter from research universities in California, the California Institute of Technology and Stanford University in my neck of the woods, University of California, University of Southern California, and what these research universities said to me in the letter was that the cuts of 5.2 percent below the 2010 level for NSF would result in far fewer grants to scientists and limit the basic research in fields such as computer science, mathematics, physics, and applied physics, which drive many of the cutting edge discoveries that power our innovation economy.

Now, you are the president Texas A&M. I mean do you agree with that assessment? What can you tell us about the impact those reductions would have on our economy if they were sustained across the budget years?

Dr. BOWEN. Well, truth in advertising. I am the former president. Their current president works much harder than I do these days. I subscribe to the content of the message you received. The dilemma that we have always is that we deal with long-term horizons. We support very fundamental research that the benefits will be seen somewhere downstream. A year from now, we probably could not identify a huge loss, a huge setback, but a few years later, we would feel the hurt. You categorize the categories of stresses that produces at the universities.

Another one is young people. Young people beginning their careers in STEM areas that plan to spend their lifetime educating and conducting scholarly research would not have the opportunity to have that small grant from the National Science Foundation to start their career. There will be impacts. We are concerned about it, but we also understand the huge pressures that are on our nation at this time to address all of these problems.

But within the isolated area that I live and the areas of my concern, you characterize the same concerns that we have.

Ms. LOFGREN. Dr. Suresh, I wonder if it is fair to ask you that same question. We had a reduction, and, yes, I mean we have a budget problem, and we need to deal with that. I don't think there is any disagreement from anybody on this panel. The question is how to do it, and one of the big fighters of deficit is prosperity. So the concern I have is if you unwisely reduce investments in science and education, you are killing your future prosperity.

Dr. SURESH. Thank you for the opportunity to respond, Ms. Lofgren. Let me just give you what the impact would be, the impact, compared to the Fiscal Year 2011 request. There will be 1,800 fewer awards and 20,300 fewer people will be supported if this level is passed. If you compare it to the 2010 enacted level, there will be 500 fewer awards and 5,500 fewer people will be supported because of this.

In the area of STEM education, which was referred to earlier, the impact will be 5,000 fewer people with respect to the 2011 request, and 4,400 fewer people compared to the 2010 request.

Ms. LOFGREN. I don't know if there is time to quickly get into the Science and Engineering Beyond Moore's Law, but can you tell us anything very quickly about what that is going to do?

Dr. SURESH. It is a very important topic. For truth in advertising, I have spent a lot of time in your neck of the woods, and at one time, I was fortunate enough to hold chair at Cal Tech, so I personally know Mr. Moore whose——

Ms. LOFGREN. So do I.

Dr. SURESH. —which is named after him is expected to come to an end in this decade. One of the things that research funding that NSF funds, with respect to Science and Engineering Beyond Moore's Law, is to look into new ways of doing computing, new ways of creating computational engines, whether it is handheld or computers and computer chips that could inform new technologies.

For example, there is a new material for which the Nobel Prize was given in physics last year called graphene, and helping to engage graphene into the manufacture of a computer chip. And when we look at nanoelectronics, which the Chairman referred to earlier, as the dimensions in a computer chip, which is about the size of a thumbnail, we have tiny copper wires.

They carry current of magnitude more than the current density that is carried by the electrical wiring in this room. If we send the same amount of current here, this building will burn down in no time. The computer chips are so efficient. And one of the things that the science and engineering beyond Moore's Law talks about is how do we manage the heat that is generated by computers while increasing their speed and increasing their efficiency.

There are a number of other things. Single molecule computing and so forth.

Ms. LOFGREN. I can see my time is up, and the Chairman has been very kind to indulge the answer, so I will have to follow up with you further. Thank you, Mr. Hall.

Chairman HALL. Thank you very much. Chair at this time recognizes Dr. Bartlett, gentleman from Maryland.

Mr. BARTLETT. Thank you. I was just wondering how our metric was going. As I was sitting here, I was thinking about the confusing set of weights and measurements we have. I remember one of my favorite teachers was Dr. Moses Warton Young from Howard Medical School. And when the medical students came in, he wanted to know where he needed to begin in teaching them. So he said he was going to begin with a nursery rhyme to see how they did.

There was a crooked man who walked a crooked mile and found a crooked style—crooked sixpence beside a crooked style. So he I want to know three things. What is a six-pence? What is a mile? And what is a style? And almost none of the students knew what a six-pence, a mile, and a style were. So now he said he knew where to start. You need to start at kindergarten with them.

We do indeed have a confusing set of measurements, don't we? Temperature, it freezes at 32 and boils at 212. If it was the Centigrade scale, it is zero and 100. It makes a lot of sense, doesn't it?

In surveying, we still use rods and chains and perches. When you buy farm fence, you buy it in a 20-rod roll, which is 330 feet. If you buy fence for your lawn, you buy it in a 50-foot roll or a 100-foot roll. We measure the depth of water by fathoms. Sixteen ounces to a pound, but not all ounces are equal. You have different kinds of ounces. Two thousand pounds to a ton but not all tons are equal. You have short tons, and you have long tons. In length, we have inches, but they are not divided decimally. They are divided by quarters and eighths and sixteenths and thirty-seconds and so forth. And we have 12 inches to a foot and three feet to a yard.

Because I buy things from other countries, I have two complete sets of tools to handle the metric things and those that are made in our country. When it comes to weight, when I was a researcher, I knew the weight of my rats. They were in grams, and a really big one was a kilogram. That is a big rat. I never thought of my weight in kilograms. I always thought of my weight in pounds. So I lived in two different worlds in thinking about weight.

Grams and liters and so simple. It is a milligram and it is a kilogram, and it is a centimeter, and it is a kilometer. And you can go both ways, and all you do is move the decimal. In thinking about surface measurements, we have acres, and I had forgotten what an acre was, but I knew that there were 640 acres in a square mile. And I thought I remember a mile was 5,280 feet. So I divided—so I multiplied. I squared 5,280 feet. I got 27,878,400. I divided it by 640, and my acre is 43,560 feet if I did the math right. Is that what an acre is? Gee we really do have a confusing set of weights and measurements, don't we?

That has to be a real burden on our economy. It really costs us a lot of extra money to do these things. How are we coming at moving metric? You know we buy things in meters, and my car has—I can now look. I have a Prius, and I punch the wrong thing, I am really speeding. I am going in kilometers rather than in miles per hour.

How are we coming in moving metric, which we really need to do, don't we?

Dr. SURESH. Mr. Bartlett, by having switched at age 21 overnight from the metric system to the English system, I feel the pain. With respect to the weights that you mention, pounds versus kilograms,

personally I always use kilogram because it is 2.2 times smaller than the pounds. So I look lighter when I measure that.

Mr. BARTLETT. That is true.

Dr. SURESH. But to your question, the National Institutes of Standard and Technology is the primary organization that is interested with weights and measures and standards for the country. I am sure Pat Gallagher, when he testifies, will respond to that question. But NSF does basic research, and as a graduate student here, I did all my homework problems in both the metric system and the English system.

Mr. BARTLETT. It just has to be a pretty big burden on our economy. Just the two sets of tools that every garage and every homeowner has to have. That is costing us something, and there are enormous confusions and inconsistencies and so forth.

It has been years now we have been trying to do this. What do we need to do to the culture so that we can get there?

Dr. SURESH. I think it has to start with education early on, and we need a national standard. And switching is not easy overnight because you have to switch all the tools and the costs associated with the change of the entire system. And I think this is something that is in the direct domain of National Institutes of Standards and Technology, rather than the National Science Foundation.

Mr. BARTLETT. I appreciate it.

Mr. BOWEN. If I might add a comment. I will try to be brief. I spent all of my time the last several years teaching large, undergraduate engineering classes, and you and I are approximately the same generation as I have struggled with the same kind of issues that you have.

They don't seem to be concerned. They are very flexible. They have their little calculators. They go online. All these conversion factors are right at their fingertips. It is frustrating how easily they deal with it, and I think long term, your point is well taken. And the country needs to get through this transition. But the young people that I have interacted with are quite comfortable.

Chairman HALL. Okay, thank you. The gentleman's time is up. Usually those of us on the committee here learn more when we listen to Dr. Bartlett's questions as much as we do when we get the answers. He is a great member.

At this time, I recognize Ms. Fudge for really and truly five minutes.

Ms. FUDGE. Thank you very much, Mr. Chairman. I always stay within my time. Dr. Suresh, of particular interest to this committee are the NOYCE Teacher Scholarship Program and the Math and Science Partnerships, MSP Program, that we expanded under the *America COMPETES Act*. Both of these programs have demonstrated success, and both of these programs bring teachers to high-need areas, such as my district in Cleveland, Ohio.

Rather than investing in these programs that work, the budget request proposes decreasing funding for both NOYCE and MSP by $10 million in order to start a new, $20 million teacher quality program. How did NSF arrive at the decision to decrease funding for these programs in order to fund a new teacher training research initiative? And how would the new program relate to NOYCE and MSP?

Dr. SURESH. Thank you for the question. As you said, the NOYSE Program, teacher training program and MSP program have been programs that have given us a lot of very good input and feedback. They have been funded over a period of time. The main reason, we have a long process that leads up to the budget process. So informed by the information that we have and the successful practices that have been developed from the NOYCE program and the MSP program, we thought now would be an opportunity to leverage the successes of these programs as educational practices change to leverage them through the Teacher Learning for the Future, which is the new program that you referred to, so that we can assess the elected merits of scholarship support versus teacher training support. And using these two, what is the optimum way to move forward based on evidence that we have gathered? So it doesn't in any way indicate any reduction in a commitment on our part. All it indicates is that we are, based on a lot of internal discussion that has led up to the Fiscal Year 2012 Budget Request.

We are assessing the relative merits of this, and as you said, it is the funds from those programs that will be used to create the Teacher Learning for the Future.

Ms. FUDGE. I would just suggest to you at this time of very difficult budget cuts to try to start something new that is unproven and not continue a program that is proven is a concern to me.

My second question. Last fall, the President's Council of Advisors on Science and Technology, PCAST, released a report on STEM education. One of the key recommendations of that report was that the Federal Government should establish a mission-driven R&D entity focused on the development of innovative technologies in K-12 education.

In response to that report, the Department of Education recently announced an ARPA-ED initiative, which would be funded at $90 million for Fiscal Year 2012. NSF has long supported research in this area, yet the proposed ARPA-ED initiative is housed solely at the Department of Education. I am interested in hearing how ARPA-ED will differ from current programs at NSF and whether or not NSF is planning to have a role in this effort.

Dr. SURESH. We would very much hope that NSF will have even a greater role than the collaborations that we have already with the Department of Education. We have had a long-standing collaboration with the Department of Education. You mentioned the Math and Science Partnership Program. We have also been engaged with them on a number of initiatives. Following the America COMPETES Act Reauthorization of December of 2010, we have established the National Science and Technology Committee on STEM education. I co-chair that committee along with the OSTP Deputy Director Carl Weiman. And part of the mission of the committee is to find greater ways in which NSF and the Department of Education can work together.

The other area where there is a lot of opportunity for collaboration with respect to potential ARPA-ED is in CTE, something we call CTE, Cyberlearning Transforming Education. This is a program where NSF brings in new tools with respect to improving cyberinfrastructure, and we will increasingly engage them, not just through the EHR directorate within NSF, but also through every

Directorate at NSF for potential collaborations with the Department of Education.

Ms. FUDGE. Thank you so much. Mr. Chairman, I yield back.

Chairman HALL. Thank you. I now recognize Mrs. Adams from Florida.

Mrs. ADAMS. Thank you, Mr. Chair. I want to follow up on what Ms. Fudge asked you. You are doing away with some programs and starting new programs at a time where it appears you are taking the money and then some to create new programs where they are new and unproven programs. So I just want to know how do you explain the decision making process for the terminations and reductions as well as the creation of the new programs. And is it the scientific community driving these decisions, or is it the Administration?

Dr. SURESH. That is an excellent question. NSF typically follows a process that includes input from the peer community. Whenever there is an issue, we have—we convene a panel of experts. And the panel of experts from around the country, these are the leaders in the field in the community that tell us what is the best way to engage the community. We have, as Dr. Bowen mentioned in his opening statement, we also have a Committee of Visitors who inform us what to do. And then there is a long internal process, so everything we do engages the community very, very strongly.

Mrs. ADAMS. Dr. Bowen?

Dr. BOWEN. Excuse me. I have nothing to add to his comments.

Mrs. ADAMS. Okay, well in your opening statement, and I just want to—you said the priorities established by the administration. Are you still with that statement?

Dr. BOWEN. Yes.

Mrs. ADAMS. So the priorities are set by the Administration?

Dr. BOWEN. It is one of a set of interactions we have.

Mrs. ADAMS. Okay, thank you. Scattered throughout the Federal Government are entire federal budget requests—dramatic increases in spending in clean technologies. At the Department of Energy alone, there are enormous spending increases for Clean Tech through ARPA-E and EERE, the Office of Science, the Loan Guarantee Program, the Energy Innovation Hubs, to name just a few. Similar programs are proposed throughout the government including NSF, Science, Engineering, and Education for Sustainability Portfolio, and it just goes on and on.

The Fiscal Year 2012 budget request is $998 million for this effort. This is 51 percent increase over the Fiscal Year 2010 amount and reflects 13 percent of your entire budget. Given what was just asked you earlier, given the questions asked about the CR, wouldn't it be best to prioritize your spending on things that may be, just may be are not spread across other agencies?

Dr. SURESH. So let me just briefly mention two or three factors. Unlike other agencies——

Mrs. ADAMS. Very briefly. I have another question.

Dr. SURESH. Unlike other agencies like Department of Energy, including Department of Basic—Department of Energy Basic Science, NSF does not push a particular mission. This particular program, it looks like sustainability in the broader sense. Of course, clean energy is an important part of it, which includes fun-

damental basic research that covers the wide spectrum of energy, clean energy options and alternative energy options.

Mrs. ADAMS. So you then are saying that you believe that you need $338 million in new spending on this one topic alone?

Dr. SURESH. Because this covers—-

Mrs. ADAMS. Yes or no.

Dr. SURESH. Yes please.

Mrs. ADAMS. Thank you. I just want to get to my questions. I am one of those people. And going back to another question I heard about the funding the STEM education for individuals from historically underserved populations, minorities, women, persons with disabilities. I know that Ms. Johnson touched on women, but out of the $160 million budget request for the division, $20 million for which is for new broadening participation programs, only $1.6 million is available for increasing opportunities in STEM education for women and zero is available for increasing opportunities in STEM education for persons with disabilities.

Can you please explain the rationale for this and why the division has become more narrowly focused?

Dr. SURESH. You know, a couple of quick responses that I will give to that. We launched a program a year or two ago in engineering looking at new educational opportunities for veterans coming from the recent wars. Last year, we supported this to the tune of $3.7 million, and this is an area in which we have a lot of potential opportunities, not only to attract people with disabilities, but also disabled veterans from underrepresented groups in science and engineering.

This is a topic where we are now doing—we had a retreat on this topic. We are looking into potential opportunities in which NSF can support in concert with the Department of Defense and other agencies.

Mrs. ADAMS. So you are okay with turning that over to another agency for this, but you are not——

Dr. SURESH. This is within NSF in the Engineering Directorate.

Mrs. ADAMS. So there is zero in your request is what I found. So but for the record, outside the human resource development division programs, would you please provide us with funding and programmatic details on all programs within the foundation that are either specific to serving historically underserved populations, minorities, women, and persons with disabilities that will provide special considerations for these populations?

Dr. SURESH. I will be happy to get that information to you.

Mrs. ADAMS. Thank you.

Chairman HALL. I thank you. Chair now recognizes Ms. Edwards, the gentlelady from Maryland.

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you very much, Dr. Suresh, and Dr. Bowen, for your testimony today. Dr. Suresh, I think when I saw you last, you had arrived only one day in town, so I hope that you have settled by now. I also want to say a special thank you to Dr. Cora Marrett, your deputy who is here. She has had a chance to come out to my congressional district and see what we have going on there with some STEM learning. And I think it is an important relationship that NSF has with local

communities and school systems to understand how we need to move K to 12 and beyond for STEM education.

This morning, although I have some questions of my own, I actually this morning want to ask a question on behalf of our colleague, Congresswoman Giffords, that has been provided by her staff. It is an area of focus that she has spent a lot of time on over this last Congress, and I know that were she here today, she would want to make sure that we got this on the record. As you know, she has been a strong advocate for STEM education at every level. Only by providing solid educational foundation for America's youth will we be able to compete in the 21st Century economy of tomorrow.

Congresswoman Giffords expressed that on a number of occasions here in this committee last year when she introduced the 21st Century Graduate Education Act, which authorized NSF to award grants for implementing research-based reforms and graduate level STEM education that emphasized preparation for diverse careers in the STEM workforce.

The idea that Ms. Giffords has had was to help budding American scientists prepare for the diverse career opportunities that they will face such as researching in academia, teaching in high schools or working in the national labs or industry. The 21st Century Graduate Education Act was actually incorporated into the America COMPETES reauthorization that we passed last year. And so, Dr. Suresh, I wonder if you could tell all of us, for the record, what steps NSF has taken and will take to implement this program.

Dr. SURESH. I will get you specific details on this program. On this particular program, for the record, the—we are increasing commitment for a number of programs that are aimed at graduate students from many different angles. So let me just briefly point at what they are. We will have 2,000 additional graduate research fellowships in Fiscal Year 2012. That is over and above 3,200 or so existing fellowships that we will continue.

We are increasing the cost of education for graduate fellows, which has been long overdue. In 2013, we plan to increase the living expenses, which has also been long overdue to help attract graduate students. We are also looking at the IGERT Program with 50 percent support from the research Directorates within NSF. The IGERT Program provides opportunities for graduate students in interdisciplinary research.

Then we have the Engineering Research Centers and Science and Technology Centers, which give unique opportunities for students in many interfacing with the industry, many leadership roles and so forth.

So our commitment is very strong, and it is growing. And I will get you the specific data on that particular program.

Ms. EDWARDS. If you could both share it with the committee, obviously share it with me, but also make sure that that is copied to Congresswoman Gifford's office. Thank you.

Dr. SURESH. I will be happy to do that.

Ms. EDWARDS. Thank you. With that, I yield.

Chairman HALL. I thank you. At this time, we will recognize the gentleman from Alabama, Mr. Brooks.

Mr. BROOKS. Thank you. I very much appreciate the opportunity to visit with you again. Enjoyed the visit to the NSF recently. Very impressive the people that you have collected together to administer the various programs that you all have oversight for.

I am going to focus primarily on fiscal matters. Since Fiscal Year that started October 1, 2007, deficits have averaged $1.2 trillion with the current year estimated at $1.65 trillion by the White House. And while it is most impressive that President Obama's Fiscal Year 2012 budget proposes to increase NSF funding by 13 percent or $894 million according to Dr. Suresh's testimony, I submit that it is irresponsible for the White House to propose these increases with absolutely no way to pay for them other than by raising taxes on our job creators, which, of course, will increase unemployment while mortgaging the future of our children and grandchildren while risking a government insolvency and potential bankruptcy that would likely cut national science foundation funding to zero if that risk should occur. With an economics background, I believe it is an absolute certainly that it will occur. It is not a matter of it, it is a matter of when unless we get our financial house in order and do it quickly.

In order to help prevent a Federal Government bankruptcy, Congress is going to have to make some very tough budgeting decisions. In that context, which NSF grant fields are most deserving of funding in your judgment? Which will be most likely to produce technology that will, in turn, produce American jobs?

I know you have a bunch of fields. You introduced me to a lot of department heads. In your judgment, where should we put the money if we are going to advance our technology, which will, in turn, advance jobs, which will, in turn, create wealth for America, which will, in turn, help us with these budget deficits?

Dr. SURESH. Thank you for the question. As I mentioned in my opening testimony, NSF-funded research historically over the last 60 years creates for the near term, for the long term, significant job opportunities. For example, as the Chairman mentioned in his opening remarks, we funded the two co-founders of Google when they were graduate students at Stanford when the work was not ready yet for commercial success.

Just in the last ten years, NSF-funded research centers in the area of nanotechnology have lead to 175 startups—this is just NSF-funded work—involving 1,200 companies.

So one of the things about NSF and its impact is that it is even more important in this economy than in a well-functioning economy because this is the engine of innovation for the country at a time when we have growing international competition.

Mr. BROOKS. Mr. Suresh, I am sorry. I am going to have to cut you off. Everything you said I just agree with. The NSF has done, in my judgment, a good job in advancing basic research projects that, in turn, result in technologies that result in more jobs. But my question is how do you prioritize between the various fields? I think you introduced me to 10 or 12 different divisions of research.

How do you prioritize that we put the money where there is going to be the most bang for the buck, where the American taxpayer will get the technological advances that is most likely to produce the greatest number of jobs? What is your priorities?

Dr. SURESH. We prioritize using a well-established process. We prioritize based on how the work that has been funded gives results. We periodically review them. We have a well-established peer review process. We have a process internal to NSF where we engage every layer of the organization. We get input from the community. Just in the Fiscal Year 2012 budget, we have terminated six programs so——

Mr. BROOKS. Well, do you treat all the fields the same, or do you evaluate them on a case-by-case basis?

Dr. SURESH. We evaluate them on the basis of new knowledge they create, the discoveries they produce, the impact they have both in knowledge creation and on society. So we have two criteria.

Mr. BROOKS. Well, are you—okay, I am trying to get at the specific fields that you believe are most important, not necessarily the criteria by which you, on a case-by-case basis, determine which grants to give. But which fields are the most important to create jobs? Which are the least important?

Dr. SURESH. So we have the priorities that we have articulated in the Fiscal Year 2012 budget gives specific areas. The area of new science, basic science and engineering, in broad area of sustainability. Sustainability definitely refers to clean energy, but it also refers to other things beyond clean energy. Transportation, cities, infrastructure, the basic sustainability science.

Cyberinfrastructure for the 21st century in increasing data. Cybersecurity, we will be investing in $155 million in Fiscal Year '12 in cybersecurity. Robotics is another area. NSF will be a leading partner in the National Robotics Initiative. Nanotechnology Signature Initiatives that I talked about earlier. So these are all areas where we think now is the right time to invest.

Mr. BROOKS. Thank you, sir.

Dr. SURESH. Thank you.

Chairman HALL. Thank you, Mr. Brooks. Now, I recognize Mr. Clarke, the gentleman from Michigan. And I might say we are going to have the vote shortly, and we have some decisions to make on when to come back and how we do it. I thank you, Mr. Clarke. Thank you, sir.

Mr. CLARKE. Thank you, Mr. Chairman, Dr. Suresh, Dr. Bowen. Really appreciate your testimony here. My question is really similar to many that have been already posed. My concern is with inner city kids. You know on standardized test scores, especially in the city of Detroit, they have done horribly in the areas of science and mathematics. So like other Members here, I am concerned about the proposed $41 million cut in the kindergarten through grade 12 educations provided by NSF. And also the elimination, proposed elimination of the graduate fellows program, also for kindergarten through grade 12.

Now, I am aware that the President would have the Department of Education offset some of these cuts, but in light of NSF's long history to being committed to highly effective education programs, could you help underscore what the administration's commitment is to improving science technology, engineering, and mathematics education for urban school districts?

I am really concerned about these inner city kids who many of them are from families where no one ever graduated from college.

I want them to have a chance to get a job or have a business in this new and emerging advanced manufacturing sector that you have helped promote and that is going to help put many metro Detroiters to work. I just want to make sure that every kid has a chance to get the training that they need to make money and advance manufacturing.

Dr. SURESH. Mr. Clarke, a lot of the things you mentioned resonate with me personally. I was the first one in my family to go to college so I fully understand and appreciate the comments you make. NSF is very, very strongly committed to K through 12 education, especially with respect to groups that are underrepresented, that have fewer opportunities and underprivileged—come from underprivileged areas.

You mention the GK-12 Program. The GK-12 Program has been funded by NSF for 12 years. It has had very many positive things that have come out of this, but over the last 12 years, we have also had other programs that have evolved, such as the IGERT Program, which have taken up important aspects of the spirit of the GK12 Program, and we will continue to honor the commitments that we have made for Fiscal Year '12 in the GK-12 Program as we look at new opportunities to fund, especially in K through 12 education.

So I want to underscore the fact this moving from one program to another is a realignment of priorities in the context of changes in circumstances around the country based on the information and evidence that we have gathered through long-term funding. It does no way reflect a reduced commitment, particularly toward education.

Mr. CLARKE. Thank you, Doctor. Just a follow up. Many districts, school districts, like Detroit really don't have the capacity to apply for many of your grants. How do you structure your grants in educational initiatives so that those school districts and students that are in most need can have access to them?

Dr. SURESH. Well, we look at a number of mechanisms, and one of the mechanisms is to seek input from the community on what the best ways of doing this are. And our Assistant Director for Education and Human Resources, Dr. Ferrini-Mundy, who is sitting behind me, she has recently articulated a vision for not only making commitments from what the budget of EHR is, but also bringing the best practices from all the research Directorates and involving them.

So with respect to how specifically we interface with a particular community, we seek input from the experts related to that particular community. We gather information on best practices. In fact, we are in the middle of preparing a report for the Appropriations Committee on the best practices from select schools in the country for STEM education in the K through 12 area, and take that information, apply it more broadly to situations where we have underprivileged children or children without access to good education.

Mr. CLARKE. Before I yield back my few seconds, I want to commend your work and tenure at MIT, and I enjoy—I look forward to working with the NSF staff on this issue.

Dr. SURESH. Thank you, sir.

Chairman HALL. Thank you, both. Recognize Mr. Benishek of Michigan. We are limited time now. Make your questions as short and answers as accurate as you can. Thank you.

Mr. BENISHEK. Director Suresh and Dr. Bowen, thank you for being here. Members of my district elected me because they saw that our government was spending money, more than we had. So it is distressing to see that your budgeting has an increase of 13 percent. I mean everything that we do, that you are doing, is all great, but we can't spend money we don't have. So in my view, we need to really focus on doing things effectively and spending the money wisely because frankly, we can't continue doing this. And everyone says that their program is the best and that it is very important for our future and our children.

But frankly, our children aren't going to be able to afford anything if they are trying to pay off this massive debt that we are building. More specifically, I just want to ask you one thing. This STEM education that we have all been hearing a lot about, don't you think it would be more effective to have—I am not talking about the effectiveness, which I don't even want to get into. But STEM education apparently is administered by 12 different agencies of the Federal Government and 100 different programs amongst those agencies. And this type of thing goes on among other fields as well.

Don't you think it would be much cheaper and more effective to have one agency deal with a subject like this?

Dr. SURESH. That is a very good question, Mr. Benishek. Let me just offer two brief responses to that. NSF is unique in its role compared to, let us say, the Department of Education, which has a much larger budget for STEM education implementation than NSF does. NSF's primary mission is to develop new and innovative models, validate them, test them, assess them, and then let agencies like the Department of Education take it over.

And in that context, NSF for the last many decades has played a pioneering role in creating new models for STEM education.

Mr. BENISHEK. I am talking about the effectiveness of the overall plan. Don't you think that one agency would be better off, it would be better off and more efficient and better communication if one agency did all the aspects related to this subject of STEM rather than having to share the information then with 12 other agencies?

Dr. SURESH. Perhaps for implementation, but for creating new models for STEM education, the kinds of infrastructure and capabilities that NSF has from the scientific and engineering community may not be present in the Department of Education or other agencies, where NSF is unique. And this is why we were asked for many decades to play a role in creating research models and new modes of STEM education at NSF, and this is a unique role that NSF plays for the community and for the country that, as far as I know, is not broadly engaged by other agencies even the——

Mr. BENISHEK. I understand that, but don't you think it would be better off if it was all in one agency?

Dr. SURESH. Well, perhaps for implementation but not for creating models because other agencies do not have the same flexibility in all fields of science and engineering as NSF does. NSF is the only federal agency that engages in all fields of science and en-

gineering and research in the broadest sense without pushing a particular mission.

So it is unique in that respect, and that is why I believe NSF is ideally suited to create unique models for STEM education.

Regarding your point on reducing duplication and waste, the committee on STEM education that I mentioned in response to an earlier question, the very purpose of the committee that I co-chair is to find out what all the other agencies do, how to engage with them more efficiently and how to reduce waste. This is part and parcel of our conversation.

We had a meeting about two weeks ago to look into that, and this is very much on the agenda for us.

Mr. BENISHEK. Thank you very much for your answer. I yield back the remainder of my time.

Chairman HALL. Thank you for your good questions, and I am sorry to pass fine people at the end of the line there and ask you to be as—and I won't waste any more time bitching about it. Mr. Lipinski, you are back now so you moved ahead of poor Mr. Sarbanes again. And we recognize you for five minutes. And we just have four to go, and I would like to dismiss this panel if we could as early as possible.

Mr. LIPINSKI. All right, thank you, Mr. Chairman. Dr. Suresh, as you know, I have championed research prizes, coauthoring the H Prize and writing the prize language included in the COMPETES reauthorization last year. As a result of that bill, the Federal Research Agencies now have broad, new authority to offer prizes for innovative research or solutions to critical problems. And I think that this tool is a complement to traditional research funding.

They offer a new way to incentivize high-risk, high-reward research and generate excitement about the frontiers of science and engineering. And I know that as dean of MIT's engineering school, that you have been involved firsthand with the highly successful Lemelson MIT prize. I expect that some of your students have also been part of MIT's $100,000 entrepreneurship competition.

So based on your experience with scientific prizes at MIT, I would like to hear your thoughts on how this new authority might be used at NSF and what we can do to maximize a return from scientific prizes, both at the NSF and other Federal R&D agencies.

Dr. SURESH. Thank you, Mr. Lipinski, and also thank you for taking the time from your busy schedule to visit us a couple of weeks ago with Mr. Brooks. As you mentioned, I have had the good fortune to interact with a lot of students in connection with different prize programs. Just two days ago, MIT announced the winner of this year's MIT Lemelson Program, a young woman named Alice Chen, for her work in health sciences and technology.

The prizes help to galvanize the innovative spirit of young minds, but one of the critical things, one of the reasons it is so successful in a place like MIT or other institutions is because the competitions are closely coupled with a very good and very basic science and engineering. And NSF—and this is something that is very important that we do, not only create prize programs, but also couple them to basic research and innovation.

I have charged Dr. Cora Marrett and also a chief technology officer, in collaboration with the head of our engineering Directorate

to look into best ways in which NSF can engage in various prize activities. One of the initiatives that could possibly be a vehicle for this could be the new robotics initiative.

So we are talking to other agencies. We are having internal conversations on how best to launch these prize programs so that we will have the biggest impact based on the experiences that we have from the community.

Mr. LIPINSKI. Thank you. I just wanted to, because of time, move on. Second thing I want to talk about, maybe just a make a statement here about I am concerned about our academic research infrastructure and I really—I am greatly concerned that we are underinvesting in research and teaching labs, instrumentation and shared-use facilities. And what this is going to mean is problems for the United States competing with countries like China for top talent and also lead to inefficient use of research dollars.

I think that NSF is planning on publishing an update of the report that came out in 2005 that said that there is a $3.5 billion backlog of needed renovations. So that is a great concern of mine, and I will be submitting a question for the record for you, Dr. Suresh, on that.

But I want to use the remainder of my time to talk about and ask you about advanced manufacturing. I was excited to see in your written testimony the focus on turning innovation into competitive advantage. I think that leveraging our basic research success to create jobs is tremendously important, especially in this economy. And I applaud your efforts to increase technology transfer and incubate small businesses.

And I particularly would like to register my support for the proposed $190 million advanced manufacturing initiative. The statutory basis for this initiative came from Section 506 in the COMPETES Reauthorization Act, which I had authored, and I just wanted to know a little bit more what you could tell us about what you think this program can accomplish in both the short and long term. And I also I would be particularly curious to hear your thoughts on nanomanufacturing.

Dr. SURESH. Thank you for the question. In the 1960s and '70s, NSF sponsored a variety of basic research activities in mathematic modeling and process modeling, which at that time was not funded by American industry. And that investment from NSF lead to significant advances in graphic prototyping in the country in the 1970s. And that led to major innovations for the country and the economy in succeeding years.

So manufacturing is an area that it is very strongly predicated upon basic fundamental research work. So I want to emphasize that. With particular references to nanomanufacturing, in the last 15 years or so, nanotechnology has advanced to such a point, and I can speak for hours on this because this happens to be my own——

Mr. LIPINSKI. I don't think you have that time.

Dr. SURESH. No, I know. That is why I will be very brief. We have the ability to manipulate single molecules, single atoms, and we can create objects from atomic level up. So we can go from atoms to systems, and this is an area we have unprecedented opportunities for innovation for a significant industry impact. And

that is why our colleagues at NSF felt that now is the time to put emphasis on advanced manufacturing for the future of the country.

Chairman HALL. The gentleman's time has expired. Mr. Lipinski asks good questions, and you have the right to give him an answer in writing more thoroughly, and he is entitled to it, if you want to. At this time, we recognize Mr. Hultgren of Illinois.

Mr. HULTGREN. Thank you, Chairman Hall. Thank you, Director Suresh. I am going to be very brief. I have some other questions so I will submit those as well hopefully to get your response to that. But I want my good friend, Dr. Harris, to be able to ask some questions as well. So I am just going to ask one quickly. And I represent Fermilab area and am very interested in some of the projects that they are working on.

But just wanted to ask you will NSF provide support for the experiments at DUSEL, such as the long-base line neutrino experiment, dark matter search experiments, and other underground science experiments?

Dr. SURESH. NSF has had a long and rich history of supporting basic research and physics, high energy physics, plasma physics, neutrino physics and so forth. So that commitment has not changed. We will continue to support it. With particular reference to DUSEL, the National Science Board, which Dr. Bowen chairs, decided unanimously and articulated very clearly in December of last year that the proposed stewardship model for the DUSEL was inconsistent and unacceptable with respect to NSF's mission.

As a result of this, the National Science Board, which necessarily has to authorize any funding for DUSEL beyond a certain threshold level, decided unanimously not to support this for the reasons that they very clearly articulated.

In light of this, there is—DUSEL is one of the programs that is slated to terminate in Fiscal Year 2012. Having said that, NSF continues to support basic research in areas, and we will be happy to have a discussion with the Department of Energy. There are already conversations going on. If either the Department of Energy, or other agencies, were to come up with a appropriate stewardship model, NSF will be happy to work with them to look into ways in which we can collaborate and fund innovative science in the physics area that is relevant to DUSEL.

Mr. HULTGREN. Well, I really do hope we have support there. Many have already come along. I know universities are a part of this. Much has been spent already to pursue this. I think also we have to realize we have lost so many of our best and brightest now going over to Europe with the work that is going on there. We need to have important researches being done here to keep our best and brightest working here in America.

So I want to encourage you to do that. I want to work with you on that however I can, but I just wanted to let you know how important that is to me, something I believe we need to be a part of as the Federal Government with that basic scientific research. So thank you. With that, I will yield back. Thanks, Mr. Chairman.

Chairman HALL. Thank you. Time has expired. Chair recognizes Mr. Sarbanes from the state of Maryland.

Mr. SARBANES. Thank you very much, Mr. Chairman. I will be brief as well. We are hearing a lot from our constituents on dif-

ferent issues. We obviously hear concern about the fiscal situation of the country and desire to have us tighten our belts and be prudent in making these tough choices.

But the other theme I hear as I move around my district is a real recognition that we need to rebuild this country, that while we were sleeping, in effect, the infrastructure of the country has been crumbling around us, whether you speak to physical infrastructure, building bridges, tunnels, railways, and so forth, whether you are speaking to human infrastructure, investing in human capital, civic infrastructure, building community and so forth.

There is a recognition that we need that investment. We need to rebuild the country. We are up to the task if we are given the tools and the leadership to do that. You are really focusing on that second piece, that investing in human capital, in human infrastructure, making sure in particular that the next generation is getting the skill set, the talents, the tools they need to lead us into the future.

And so I want to congratulate you on and commend you on staying focused on that particular investment because that is going to determine whether we are successful going forward or not.

While I have you here, I just wanted to encourage you, particularly around STEM education and I think you are preaching to the choir in many respects really across the aisle here in recognizing the importance of science, technology and these other investments that we need to make. I have been working for a while on something called No Child Left Inside, which is an attempt to get outdoor education promoted, environmental education really well integrated into the instructional programming in our schools across the country. And one of the reasons is because when you look at programs in schools that emphasize environmental education and get children outdoors applying what they are learning in science classes to the outdoors and all the stimulation that goes with that, what it does is it triggers their interest in pursuing careers in science and technology and so forth and engineering and math.

So I am just asking you if you will be receptive to our providing you with more information about the NCLI initiative and opportunities for NSF to collaborate on that initiative and promote that kind of imagination and innovation for the next generation.

And with that, I will yield back my time, Mr. Chairman. Thank you.

Chairman HALL. Sure. Thank you. I would tell you we have about 10 minutes until we have to vote. Dr. Harris, we recognize you for such a time of the five minutes as you choose to use. Thank you.

Mr. HARRIS. Thank you, Mr. Chairman. Thank you, Dr. Suresh, for being here. And I am just going to follow up a little bit on what Mr. Brooks from Alabama had to say. And I appreciate science. I always have my whole life obviously. But the fact of the matter is that you use the word invest many times in your written testimony. But I will tell you the only investing going on now are foreign governments, including China, investing our bonds because we are running a $1.5 trillion deficit. And, Dr. Suresh, you are a scientist. You have seen the same curves I do. You know it is not sustainable. It is just not. It is black and white. It is not sustainable.

So we do have to look at ways to cut, and I am a little disappointed.

You know you got $3 billion in stimulus funding. Stimulus was sold to the American public as a one-time expense that has to be paid back. Every single dollar of the $787 billion was borrowed, with over half those dollars coming from foreign ownership of those bonds. And they do need to be repaid, and I think they need to be repaid starting now. The stimulus idea was let us move up some spending, and then let us pay it back.

So I am disappointed to hear that you think a five percent cut in H.R. 1, I think that is what you said, a 5.2 percent cut, which you would have gotten in H.R. 1, having gotten $3 billion, a 50 percent increase in your funding a couple years ago, is something that you think well the sky will fall. I am kind of disappointed to hear that.

But the priorities are such that—and I know your—does your agency do anything with economics? I mean does it do economic science forecasting? That is—you don't have anything to do with that?

Dr. SURESH. We have a Directorate called Social Behavior and Economics Directorate.

Mr. HARRIS. You do? Okay, do you know if they have done any—I mean was it a priority for that Director to do any studies on the effect of our debt growing above our GDP? Could you get that to me because we have limited time? If you can get that to me, I am a little surprised that the administration didn't make that a priority for your organization given the fact we are on a fiscal—we are at the edge of a fiscal cliff with that.

But the only thing, again I want to just follow up with the gentlelady from Florida, what she said about I am a little puzzled by this duplication. I have been—now this is the—I think it is the third budget hearing in this committee. Every single one by organization has a climate research and says their climate change research is absolutely essential. I don't think that is part of what I think of the National Science Foundation. And NOAA came in, EPA, and Department of Energy, all with this.

The GAO just came out with their famous finding that there is an incredible amount of duplication within the agencies, so I am going to ask you to just answer in writing what your agency has done to make sure that there is no duplication at all in what all those other agencies are doing about climate change.

Because I am afraid—and again, look, I had NIH grants when I was in medicine. I know the way it works. You have a wide variety of agencies. It takes a lot of time when different groups are requesting grants, it takes a lot of your intellectual energy to prepare all those different grants, so consolidating these kind of things would be useful. And, Mr. Chairman, I yield back the balance of my time.

Chairman HALL. Okay, I thank you, and I do thank Dr. Suresh and Dr. Bowen for good answers, good timely answers. Sorry we were pressing, but we now have about eight minutes to get over there to vote. It will take about four minutes to get there, two minutes for staff to tell us how to vote, and about a minute to vote.

We are going to excuse you both and thank you very much, and to the group that will be testifying on NIST, we will be back probably within 45 minutes, 15 after the last vote over there.

Dr. SURESH. Thank you, Mr. Chairman.

Chairman HALL. She said five minutes after the last vote. We will settle for 7-1/2 minutes. Is that okay? I thank all of you.

[Recess.]

Chairman HALL. I thank you, and we are back in session with appreciation for the past two witnesses, and our second panel is Dr. Patrick Gallagher, Under Secretary of Commerce for Standards and Technology and Director of NIST. And I want to particularly thank Under Secretary Gallagher for waiting so patiently through the first panel. I think you were here the whole time. I kept waiting for you to go up there and tell them just five minutes in their sixth or seventh minute.

And we thank you. We have to be flexible with you. You have been too good. So at this time, I will welcome Dr. Gallagher. Prior to his service at NIST, he served as Director for one of the NIST user facilities, the Center for Neutron Research. And Dr. Gallagher started in 2008 as acting Director of NIST and was confirmed as Director in November of 2009. As a practicing physicist, he has a unique understanding of the inner workings of NIST.

As the witness should know, spoken testimony is limited to five minutes, after which the Members of the Committee will have five minutes each to ask questions. And most of us have an airplane to catch, and I know the Chairman wants to get back to his office. So at this time, I thank you for your testimony in about five minutes from now. Thank you, sir. Go ahead.

STATEMENT OF PATRICK GALLAGHER, UNDER SECRETARY OF COMMERCE FOR STANDARDS AND TECHNOLOGY, AND DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Dr. GALLAGHER. Thank you, Mr. Chairman. I will respect your time and I appreciate the Committee. Congresswoman Edwards, thank you as well and Members of the Committee for this opportunity.

The NIST mission to promote U.S. innovation and industrial competitiveness is well aligned with the President's goals of supporting economic growth through innovation, infrastructure, and education in a time that we know to be a very tough budget environment.

The Fiscal Year 2012 budget request for NIST is $1 billion. This represents a 17 percent increase over the Fiscal Year 2010 enacted level. Let me briefly summarize the request. For NIST Scientific and Technical Research Services account, which funds our laboratory activities, the budget request is $679 million, a net increase of $174 million. These funds will accelerate the development of standards, technology and measurement science in areas as diverse as advanced manufacturing, cybersecurity, and critical infrastructure.

For the NIST Industrial Technology Services account, the budget request is $238 million, an increase of $33 million, and it reflects a $1.9 million reduction to the Baldrige Performance Excellence

Program consistent with the Administration's goal of transitioning this program out of federal funding.

The budget requests $84.6 million for the Construction of Research Facilities account. This represents a $62.4 million decrease. The construction request includes $25.4 million for the continued renovation of the aging Boulder Building 1 facility and funds for needed repairs and maintenance of our facilities at our two campuses.

Finally, NIST requests $100 million in new mandatory account for the creation of a public safety infrastructure fund. This is NIST component of the President's Wireless Innovation and Infrastructure Initiative (WI3).

Let me touch on several major themes that are in the request. Those are manufacturing, infrastructure and education. The President's 2012 budget for NIST includes a strong focus on advanced manufacturing to provide the measurement tools and other essential technical assistance that U.S. manufacturers need to invent, innovate, and produce and to do that more rapidly—and more efficiently than their competitors.

Within the laboratory budget, there are five manufacturing-related initiatives totaling $85.3 million. These initiatives will enable NIST to bolster and diversify needed research and services in areas like nano and biomanufacturing, additive manufacturing, and advanced robotics that will strengthen U.S. competitiveness. My written testimony discusses each of these in more detail.

The President's budget also strongly supports manufacturing through the Manufacturing Extension Partnership and the Technology Innovation Programs. For MEP, the budget request is $143 million. This is an $18 million increase. NIST's MEP will expand the capabilities of its nationwide network of centers located in all 50 states in a number of critical ways to assist manufacturers to successfully compete over the long term.

And the request for TIP of $75 million enables the program to hold competitions to fund high-risk, high-reward research in critical national need areas like manufacturing.

NIST is also requesting $12.3 million for the Advanced Manufacturing Technology Consortia, or AMTech. This new program is a public/private partnership program to provide grants for the formation of industrial consortia to address industrial-driven technology challenges that no one company can solve on their own.

With regard to strengthening the U.S. infrastructure, the budget contains $43.4 million in three initiatives for cybersecurity-related programs and activities. This includes initiatives building upon NIST core cybersecurity work in support of the Comprehensive National Cybersecurity Initiative, to support a national program office to coordinate activities for the National Strategy for Trusted Identities in Cyberspace, or NSTIC, and to expand the scope of the Comprehensive National Cybersecurity Initiative Education Initiative.

In the area of interoperability infrastructure, the budget proposes an initiative to focus on the standards needed for smart grid, an interoperable system of electronic medical records, and for cloud computing.

The physical infrastructure initiatives in NIST will further development of increased energy efficiency and environmental impact for

manufacturing and support more disaster-resistant structures. In light of this morning's news from Japan, this includes efforts to support disaster-resistant infrastructure or what are called lifelines in the community that are so critical to the survivability of a community under natural disaster scenarios.

And I would remind the Committee that NIST is the lead agency in the Interagency National Earthquake Hazard Reduction Program, a critical effort in this regard.

And finally in the wireless infrastructure, the Public Safety Innovation Fund that I mentioned earlier will focus our efforts in support of providing our public safety community with a network-based emergency communication infrastructure. This budget incorporates over $11 million in administrative savings and the proposed decrease for the Baldrige Programs saves an additional $1.9 million.

Mr. Chairman, the Fiscal Year 2012 budget request for NIST reflects the Administration's recognition of the important role that NIST can play in innovation, and I thank you for this opportunity. I look forward to answering the Committee's questions.

[The prepared statement of Dr. Gallagher follows:]

PREPARED STATEMENT OF DR. PATRICK D. GALLAGHER, PH.D.

Chairman Hall, Ranking Member Johnson, and members of the Committee, thank you for the opportunity to appear before you today to present the President's Fiscal Year (FY) 2012 budget request for the National Institute of Standards and Technology (NIST). This budget reflects the important role that NIST plays as part of President Obama's Plan for Science and Innovation. As the President has said."We know what it takes to compete for the jobs and industries of our time. We need to out-innovate, out-educate, and out-build the rest of the world."[1] The NIST FY 2012 budget clearly lays out the NIST role in the Administration's priorities by making critical investments in key areas that will help preserve our nation's economic security and strengthen American competitiveness.

Mr. Chairman, I would like to start with a quick mention of the context of this budget. Overall, this is a very difficult budget environment. The President made clear that it was important for the government to live within its means and establish some priorities within those limits. The President has focused on a number of key goals, including innovation, infrastructure and education.

Within that context, NIST finds itself with a mission that's very well aligned to those goals. Over the past few years, numerous reports have underscored the importance of a robust Federal presence in the sciences to advance technological innovation. The "Rising Above the Gathering Storm" report and its follow-on, "The Gathering Storm, Revisited," were a clarion call to action that helped to shape the America COMPETES Reauthorization Act that this Committee championed and the President signed into law earlier this year. In addition, in February of this year, the White House Office of Science and Technology Policy, National Economic Council, and Council of Economic Advisers jointly released an update to the 2009 "Strategy for American Innovation" that "focuses on critical areas where sensible, balanced government policies can lay the foundation for innovation that leads to quality jobs and shared prosperity."

The NIST mission is to promote U.S. innovation and industrial competitiveness through measurement science, standards and technology. The NIST mission is very well-aligned with the priority goals that the President has laid out. The FY 2012 budget for NIST reflects that alignment.

Mr. Chairman, the President's FY 2012 discretionary budget request for NIST is $1 billion, a 17 percent increase over the FY 2010 enacted level. The budget maintains the President's commitment to double the NIST laboratory budget, and to support and enhance our world leadership in the physical sciences and technology.

The NIST budget is comprised of three discretionary spending accounts and one new proposed mandatory spending account.

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[1] Remarks by the President in State of Union Address on January 25, 2011.

For the NIST laboratories, the budget requests $679 million to accelerate the development of standards, technology, and measurement science in areas as diverse as advanced manufacturing technologies, cybersecurity, and infrastructure. The request reflects a net increase of $173.6 million over the FY 2011 annualized CR level. We did not continue funding $10.5 million in previous year earmarks and redirected this amount to new initiatives. Thus, the budget proposes $178.5 million in laboratory initiatives and $5.6 million in adjustments to base.

For the NIST Industrial Technology Services (ITS) account, the budget requests $238 million, an increase of $33 million over FY 2011 annualized CR levels. The account includes NIST's external programs: the Technology Innovation Program (TIP), the Hollings Manufacturing Extension Partnership (MEP), the Baldrige Performance Excellence Program (BPEP) and the newly proposed Advanced Manufacturing Technology Consortia (AMTech) program. The request includes $12.3 million for the AMTech, a new cooperative grant program with industry and academia to foster public-private partnerships to develop needed technology to support advanced manufacturing industries that will broadly benefit the Nation's industrial base. Also in the ITS line is a $1.9 million reduction to BPEP from the FY 2011 annualized CR levels.

The budget requests $84.6 million for the Construction of Research Facilities (CRF) account; representing a $62.4 million decrease from the FY 2011 annualized CR level. The request includes $25.4 million for the continued renovation of the Boulder Building 1 renovation but does not include $67 million in FY 2010 earmarks and the Construction Grant Program.

Finally, NIST requests $100 million in mandatory appropriations for the Public Safety Innovation Fund, NIST's component of the Wireless Innovation Fund, which itself is part of the President's Wireless Innovation and Infrastructure Initiative (WI3). This mandatory appropriation request will fund NIST's safety efforts in this area, with particular focus on working with industry and public safety organizations to develop new standards, technologies, and applications to advance public safety.

Let me speak in more depth about the major thematic initiatives in this request: manufacturing, infrastructure, and education. These themes directly relate to the President's stated goals to "out-innovate, out-educate, and out-build."

Out-Innovate: Supporting Innovation for a Strong Manufacturing Base.

In order to "Out-Innovate," the U.S. must have a strong manufacturing base. With that focus innovation in manufacturing is key to the NIST 2012 budget. In the area of manufacturing, U.S. industry faces relentless competition that has trimmed the nation's share of global manufacturing output from 25 percent in 2000 to about 20 percent today.

The U.S. manufacturing sector, still the world's largest, is the nation's innovation engine. Manufacturers perform half of all research and development in the U.S., and they employ 17 percent of the nation's scientists and engineers. The sector develops, builds, and supplies the advanced equipment that enables the U.S. military to maintain technological superiority over our adversaries.

Providing the measurement tools and other essential technical assistance that existing U.S. manufacturers and aspiring start-ups need to invent, innovate, and produce-more rapidly and more efficiently than their competitors-is a top NIST priority. NIST has partnered with the manufacturing sector for over a century. Today's challenges require stepping up efforts to enhance and strengthen the nation's underlying technical infrastructure, which is integral to our innovation and advanced manufacturing capabilities.

To reap the economic benefits of our ability to innovate, our nation's manufacturing sector must be able to renew itself by adopting new technology and developing new markets. The nation's manufacturers must respond quickly and effectively to an ever-changing mix of requirements, risks, and opportunities, from new regulations to rising energy costs to emerging technologies and markets. The revitalization of the U.S. manufacturing base is critical to driving innovation and job creation in the future and will play a major role in building an economy that can help raise the standard of living for all Americans.[2]

2012 Manufacturing Initiatives:

The President's FY 2012 budget for NIST includes five manufacturing-related initiatives in NIST's scientific laboratories that will enable NIST to bolster and diver-

[2]Executive Office of the President, A Framework for Revitalizing American Manufacturing, Dec. 2009.

sify needed research and promote proven services that will strengthen U.S. manufacturing competitiveness in high-value-added product markets.

- *Strengthening Measurement Services in Support of Industry Needs ($20.0M)* The U.S. economy depends upon a robust and reliable physical science-based measurement system. Industry is increasingly relying upon and utilizing NIST's precision time and synchronization services to drive innovation. Industries as diverse as telecommunications, electric power distribution, broadcasting, and navigation networks, as well as many crucial applications in national defense, intelligence, and homeland security rely on NIST calibrations and measurement services. In aeronautics, for example, NIST calibrations for commercial and federal government partners ensure the accuracy and performance of altimeters and electrical systems that enable F-18s and commercial aircraft to fly. This initiative will enhance systems for distributing NIST measurement services to meet the growing demand from industry for such services.
- *Advanced Materials for Industry ($14.2M)* The discovery and optimization of new materials is costly and inefficient. Today, U.S. researchers can design and create new materials at a rate that outpaces our ability to support the measurements to characterize and exploit these discoveries. NIST efforts in advanced materials development and measurement science can help manufacturers save millions of dollars in design costs. This initiative will help to provide that support to industry through the development of a national measurement and standards infrastructure necessary to enable computer modeling and simulation capabilities for discovering new materials and reliably optimizing structures and properties for manufacturing processes and product performance and features.
- *Innovations for 21st Century U.S. Manufacturing: Faster, Smarter and Cleaner ($13.3M)* Innovation is central to manufacturing, and in turn, to the overall growth and health of the U.S. economy. The ability to rapidly introduce product innovations provides a foundation for future growth in U.S. manufacturing and with it, the creation and retention of high-skill, well-paying jobs. This initiative will fund efforts to develop advanced robotics technologies that allow the U.S. to retain manufacturing competitiveness, and fund programs that will promote sustainable operations and improve energy efficiency in both the manufacturing and construction sectors of the economy.
- *Measurement Science and Standards to Support Biomanufacturing ($9.5M)* The high cost of biotechnology medicines is adversely impacting the U.S. healthcare system and economy. Biotechnology drugs, currently dominated by protein therapeutics, are the fastest-growing class of pharmaceuticals and the fastest growing (~20%/year) category of health care spending.[3] Inefficiencies in the manufacturing process contribute to the high cost of these drugs. Under this initiative, NIST will work closely with industry, the FDA, and other standards organizations to better understand the manufacturing process resulting in higher quality biologic products through continuous improvement of manufacturing processes. It will also enable the development of agile biomanufacturing processes required for next generation products such as stem cells and personalized biotherapeutics.
- *Measurements to Support the Manufacture and Production of Nanotechnology-based Products ($28.2M)* There remain significant barriers to the full commercial exploitation of nanotechnology. The lack of manufacturing and characterization tools adds significantly to the development cost of nano-based products. Rigorous measurement science is needed to characterize the environmental, health, and safety risks of engineered nanomaterials. NIST's expertise in measurement science as well as its world-class nanotechnology fabrication facilities at the Center for Nanoscale Science and Technology (CNST) in Gaithersburg, Maryland, provides industry unique resources to advance the measurement science needed to enhance our understanding of the safety of nanomaterials, and fund research on the development and manufacture of cost-competitive technologies. This initiative will position the U.S. to be globally competitive in emerging technologies through safe use of nanotechnology. It will also provide needed investments in the CNST to keep it at the cutting-edge of innovation.

[3] Biotech 2008—Life Sciences: A 20/20 Vision to 2020, Burrill and Company, 2008.

The President's budget strongly supports manufacturing through the Industrial Technology Services programs.

Hollings Manufacturing Extension Partnership (MEP)

The President's 2012 Budget requests $142.6 million for the MEP program. This request is a $17.9 million increase over the FY 2011 annualized CR level. The MEP is a federal-state partnership which requires a two-thirds financial match from non-NIST sources. Through its national network of MEP Centers located in every state, 1,400 technical experts help small- and medium-sized manufacturers navigate economic and business challenges and connect to public and private resources essential for increased competitiveness and profitability.

Through competitively awarded cooperative agreements, NIST MEP will expand the capabilities of its nationwide network of centers to accelerate commercialization of technological innovations, adopt environmentally sustainable business practices, promote renewable energy initiatives, foster market diversification, and connect domestic suppliers to manufacturers to assist manufacturers in successfully competing over the long term in today's complex global manufacturing environment.

The Technology Innovation Program (TIP)

The FY 2012 request for TIP is $75 million. The proposed TIP budget represents an increase of $5.1 million above the FY 2011 annualized CR level. TIP funds cutting edge, transformative research and development projects that address critical national needs and societal challenges not already being addressed by others. TIP requires a 1:1 match of funds from the private sector. In FY 2012, TIP expects to hold a funding competition in one or more of the following research areas: advanced robotics and intelligent automation, energy, healthcare, water, civil infrastructure technologies, and manufacturing.

TIP funding will incentivize innovative research and development (R&D) projects, conducted by small- and medium-sized U.S. based companies, alone or as joint ventures with universities, national laboratories and other non-profit research organizations. Further, it will foster research collaborations, enable the creation of intellectual property in the United States, disseminate new knowledge, and advance the state-of-the-art in technologies that address societal challenges. In its most recent round of funding for manufacturing projects, TIP awardees included those young, small companies which are the engines of innovation and the future generators of globally competitive jobs.

Advanced Manufacturing Technology Consortia (AMTech)

NIST is also requesting $12.3M for the Advanced Manufacturing Technology Consortia (AMTech) program, a new public-private partnership that will broadly benefit the Nation's industrial base by providing grants to form and fund industrial consortia to address industrial driven technological challenges that no one company can address alone. AMTech is modeled upon NIST's successful partnership, the Nanoelectronics Research Initiative, which in collaboration with industry, funds research consortia targeting the nanoelectronics technology sector.

AMTech will collapse the timescale of technological innovation by including partners that span the innovation lifecycle from idea to discovery, from invention to commercialization. Through cost-sharing and a common research agenda, these consortia would support the development of innovative new technologies directed at creating high-wage jobs and economic growth across the industry sector. These consortia will develop road-maps of critical long-term industrial research needs and provide support for research and equipment at leading universities and government laboratories directed at meeting these needs.

Out-Build: Building the Nation's Infrastructure—Cyber, Physical and Wireless

To meet the President's challenge to "Out-Build" other nations, NIST is requesting funds in the FY 2012 budget to strengthen the U.S. infrastructure in three main areas: the cyber infrastructure, the physical infrastructure and the wireless infrastructure.

Cybersecurity Infrastructure. A secure cyber infrastructure is vital to the economic vitality and national security interests of the United States. In addition to enabling more than $200 billion in annual e-commerce, interconnected networks of computers are essential for critical functions such as air traffic control, electric power distribution and the GPS in our cars. The nation's cyber infrastructure is central to maintaining the timely delivery and quality of public services that are part of everyday life. Our nation's computers face ever-increasing threats from malicious

individuals, organizations, and nation states. Currently, our computer security tools are manually implemented, too complex to be effectively used, and too static to respond to rapid changes in the threat environment. This allows many attacks to succeed, causing significant damage and undermining confidence in vital commercial and public information systems. The result is a large, direct economic impact—estimates show that Americans lose billions of dollars each year to cyber crime.

NIST is responsible for cybersecurity research, development of federal cybersecurity standards, establishment of methods and metrics for determining the effectiveness of security controls, and providing technical support to public and private sector implementation of security standards and controls. The FY 2012 budget request contains $43.4 million for cybersecurity related programs and activities that will strengthen NIST's contribution to the development and promulgation of effective and usable cybersecurity standards.

The cybersecurity infrastructure request has three initiatives.

- Scalable Cybersecurity for Emerging Technologies and Threats ($14.9M) The request would provide improvements to NIST's core cybersecurity work in support of the Comprehensive National Cybersecurity Initiative (CNCI), the Federal Information Security Management Act (FISMA), and other national priorities. NIST will develop improved security techniques, support the creation of consensus security standards, increase the interoperability and usability of security technologies, and expedite the secure adoption of emerging information technologies.
- National Program Office for the National Strategy for Trusted Identities in Cyberspace (NSTIC) and NSTIC Grant Program ($24.5M) The request would support a National Program Office (NPO) to coordinate federal activities needed to implement NSTIC. This initiative is in direct response to the recommendations of the White House Cyberspace Policy Review and will raise the level of trust associated with the identities of individuals, organizations, services, and devices involved in online transactions. NIST will be responsible for day to day and overall operation of the NPO. NIST will work with the private sector to identify potential funding opportunities for the delivery of NSTIC solutions. Of the $24.5 million for NSTIC, $7.0 million will support a National Program Office and $17.5 million will fund the pilot grants.
- National Initiative for Cybersecurity Education (NICE) ($4.0M) The request supports NICE, which expands the scope of the Comprehensive National Cybersecurity Initiative's (CNCI) Education Initiative from the training of the Federal workforce to a larger national education focus. NIST will develop a cybersecurity education framework that addresses: national cybersecurity awareness, formal cybersecurity education, Federal cybersecurity workforce structure, and cybersecurity workforce training and professional development.
- Interoperability of Infrastructure. Other critical emerging technologies such as the Smart Grid and national health care information systems have the potential to transform our society and revitalize the U.S. economy. To be effective, the many interconnected components in these systems must be fully interoperable to allow information to be exchanged and used seamlessly across systems. As a respected and trusted technical partner, NIST is uniquely positioned to bring together stakeholders from industry, government, academia, and standards development organizations to establish consensus-based interoperability standards and conformity tests. The President's budget request for NIST contains an initiative that will support continued efforts in these critical areas as well as provide the infrastructure necessary to address other emerging interoperability challenges.
  - The Interoperability Standards for Emerging Technologies Initiative ($23.8M), will focus on the development of standards to enable or accelerate the successful development of new technologies such as a smart electrical grid (Smart Grid), interoperable electronic healthcare records, and cloud computing. These technologies have the potential to transform our society and galvanize U.S. industry, and provide new opportunities for exports of U.S.-developed technologies. For each technology to be effective, however, many complex interconnected components must be built to be enable full interoperability and reduce the full potential of these technologies. Lack of standards for interoperability can significantly slow adoption of these emerging technologies, dampen confidence in industry, and increase the risks of stranded investments in solutions that quickly become obsolete.

- Physical Infrastructure. Buildings in the U.S. consume 72 percent of all electrical energy produced in this country. Emissions associated with buildings and appliances are projected to grow faster than those from any other sector. To ensure adequate supplies of energy and curtail the projected growth of carbon dioxide emissions, it is essential to reduce building energy consumption significantly while minimizing the environmental impacts of buildings during their life cycles. In addition, many of the nation's largest buildings and much of its infrastructure are concentrated in disaster-prone regions where hurricanes, earthquakes, floods and other hazards are common. Catastrophic failures in infrastructure as a result of natural disasters are costly and directly impact our personal and economic health. NIST is requesting funds for two initiatives that will further the development of a stronger building infrastructure.
  - Measurements and Standards to Support Increased Energy Efficiency and Reduced Environmental Impact initiative ($13.3M) This initiative will fund research in Net-Zero Energy Building (NZEB) design. NZEB designs would use as much energy from renewable sources as they consume. Such design also doubles the service life of building materials, products, and systems in order to minimize their lifecycle impacts—this also takes indoor air quality into account. Current analysis methods are not able to assess the indoor air quality impacts of key design decisions or impacts of new technologies. This initiative will provide the measurement science required to achieve net-zero energy, high-performance buildings. It will also provide the measurement science to support gas measurement standards to ensure their accuracy and comparability.
  - Measurements and Standards to Support Advanced Infrastructure Delivery and Resilience ($10.6M) The disaster resilience of our structures today is determined in large measure by the building codes, standards, materials, and practices used during their construction. There are gaps in the measurement science needed to improve the disaster resilience of infrastructure exposed to natural and man-made hazards. This request funds efforts to provide improvements to our nation's physical infrastructure to damage from earthquakes, windstorms, and fire. This funding will also develop comprehensive measures of construction practices so our Nation's building infrastructure can be both more efficiently built and more resilient.

Wireless Infrastructure. The request to create the Public Safety Innovation Fund (PSIF), a mandatory account within NIST funded at $100 million ($500 million over five years) is part of the Administration's Wireless Innovation and Infrastructure Initiative (WI3).

President Obama called for a National Wireless Initiative to make available high-speed wireless services to at least 98 percent of Americans. The WI3 will make it possible for businesses to achieve that goal, while freeing up spectrum through incentive auctions, spurring innovation, and supporting a nationwide, interoperable wireless network for public safety. An important element of this plan is the reallocation of the D Block for public safety, and some of the proceeds from the incentive auctions being dedicated to NIST research, experimentation and testbeds. The funds will also focus on applied development to foster the development of a next-generation Public Safety communications network.

Specifically, to spur innovation, the WI3 includes a Wireless Innovation (WIN) Fund for research and development of emerging wireless technologies and applications. NIST will focus on applied development to foster the development of a next-generation Public Safety communications network. The current systems for 4G high speed wireless services are not tailored for public safety's requirements. Developing and implementing such requirements, including capabilities to enable handsets to operate in peer-to-peer (or without the aid of a central network) will require technological leadership that NIST can help provide. NIST, in consultation with agency partners, including the National Institute of Justice at the Department of Justice and the Department of Homeland Security, will focus on developing and testing requirements, standards, wireless applications, and other wireless technologies in support of an interoperable nationwide Public Safety Broadband Network.

Out-Educate: Training the Next Generation of Scientists.

In order to "Out-Educate," each agency must do its part. While NIST does not have a primary mission in education, the future development of the nation's scientists is critical to the future of NIST. NIST has an important role to play in helping to identify, recruit, and retain the next generation of scientists and engineers

to help drive American competitiveness. There is one initiative associated with this area:

- The Postdoctoral Research Associateship Program ($3.0M) This highly competitive program is very effective at attracting outstanding scientists and engineers to consider a career in science by providing opportunities to work alongside NIST researchers. I want to thank the Committee for its support in eliminating the cap on funding for the post-doc program. The elimination of this cap allows NIST to fund more associates. The requested increase will enable the program to offer at least an additional 23 positions per year and keep the pipeline of bright, new scientists flowing.
- National Initiative for Cybersecurity Education (NICE) ($4.0M) As mentioned earlier, the request supports NICE, which expands the scope of the Comprehensive National Cybersecurity Initiative's (CNCI) Education Initiative from the training of the Federal workforce to a larger national education focus.

Construction of Research Facilities (CRF): The FY 2012 request totals $84.6 million, a $62.4 million decrease over the FY 2011 annualized level. The request contains $25.4 million to continue the renovation of the 60-year-old Building 1 on the NIST Boulder campus, which houses the majority of research and measurement laboratories on the Boulder campus. The balance of the account, $59.2 million, will provide funding for NIST to address deficiencies and maintain NIST's laboratories and facilities. The decrease reflects the elimination of congressionally-directed projects from FY 2010.

Budget Decreases: Finally, let me touch on two areas in which the budget reflects savings: The Administration's Administrative Efficiency Initiative challenged all agencies to identify savings as part of the budget development process. NIST's FY 2012 budget incorporates over $11 million in administrative savings across the agency in order to make the agency more efficient and effective in an era of tight budgets.

The Baldrige Performance Excellence Program (BPEP) requests $7.7 million, $1.9 million less than the FY 2011 annualized CR level. The FY 2012 funding supports the continued development of the Baldrige Program Criteria, dissemination of best practices, and the annual awards process. At the proposed level, BPEP will evaluate alternative sources of funding and alternative cost models consistent with the administration's goal of transitioning the program out of federal funding.

Summary

In summary, I would like to note that for more than 100 years NIST has maintained the national standards of measurement. This role was assigned by the U.S. Constitution to the Federal Government to promote industry and ensure market fairness. The FY 2012 budget request for NIST reflects the Administration's recognition of the important role that NIST plays in innovation and the impact that the research and services NIST provides can have on moving the nation forward by laying the foundation for long- term job creation and prosperity. By sustaining our investments in fundamental research, we can ensure that America remains at the forefront of scientific capability, thereby enhancing our ability to shape and improve our nation's future and that of the world around us. I look forward to working with you Mr. Chairman and members of the Committee and would be happy to answer any questions.

BIOGRAPHY FOR DR. PATRICK D. GALLAGHER

Dr. Patrick D. Gallagher, Under Secretary of Commerce for Science and Technology and Director. Dr. Patrick Gallagher was confirmed as the 14th Director of the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) on Nov. 5, 2009. He also serves as Under Secretary of Commerce for Standards and Technology, a new position created in the America COMPETES Reauthorization Act of 2010, signed by President Obama on Jan. 4, 2011.

Gallagher provides high-level oversight and direction for NIST. The agency promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology. 2010 resources include $856.6 million from the Consolidated Appropriations Act of 2010 (Public Law 111-117), $49.9 million inservice fees, and $101.5 million from other agencies. The agency employs about 2,900 scientists, engineers, technicians, support staff and administrative personnel at NIST's two main locations in Gaithersburg, Maryland and Boulder, Colorado.

Gallagher had served as Deputy Director since 2008. Prior to that, he served for four years as Director of the NIST Center for Neutron Research (NCNR), a national user facility for neutron scattering on the NIST Gaithersburg campus. The NCNR provides a broad range of neutron diffraction and spectroscopy capability with thermal and cold neutron beams and is presently the nation's most used facility of this type. Gallagher received his Ph.D. in Physics at the University of Pittsburgh in 1991. His research interests include neutron and X-ray instrumentation and studies of soft condensed matter systems such as liquids, polymers, and gels. In 2000, Gallagher was a NIST agency representative at the National Science and Technology Council (NSTC). He has been active in the area of U.S. policy for scientific user facilities and was chair of the Interagency Working Group on neutron and light source facilities under the Office of Science and Technology Policy. Currently, he serves as co-chair of the Standards Subcommittee under the White House National Science and Technology Council.

Chairman HALL. And I thank you for staying within the five minutes and for your testimony and for those who are with you today that have helped you prepare for this and giving of their time and being so patient when we had to take time off to go vote.

And I thank the folks that are back here. The main ones are here, but the empty seats shouldn't be of any bad omen to you because this goes into the congressional record. They get copies of everything. It will be read. You will be heard by more than just three or four people here, but this is the day everybody heads for home or they have two or three other committee meetings before the end of the week. So bear with us and thank you. We know you have duties to go to, so I will not take up any more time apologizing, but I thank you very much.

I don't think I have mentioned that we really have just five minutes each of us for questions. I recognize myself for five minutes, and I will give some of that back.

Dr. Gallagher, I have a question here. Your testimony highlights a NIST initiative focusing $13 million in Fiscal Year 2012 on research related to what they call "net zero energy buildings." Explain first for the record what it means to be 'net zero'. And then why is NIST doing this work instead of the Department of Energy or perhaps the private sector? And is there coordination with other federal agencies to ensure that there is not duplication of efforts and to utilize the expertise of other agencies? That is about three questions in one, and I used up too much time even asking. You are recognized to give us a good answer to that, as accurate an insight as you can.

Dr. GALLAGHER. Right, thank you. The net zero energy buildings program is basically a goal to develop and build buildings that generate as much energy as they use. It is a stretch goal to achieve a building infrastructure that is sustainable.

In the United States, I think you know that our building infrastructure is one of our major consumers of power. It is about 40 percent of our total electricity and the energy budget goes into our building infrastructure. So if we can make reductions and make improvements in the efficiencies of our building infrastructure, we can really have big benefits.

The way to achieve net zero energy buildings is a combination of high efficiency components, so it is certainly about energy efficient appliances, heating and cooling systems, but it is also about the optimization of those components into a working building. And then on top of that, it is about adding distributed energy generation, things like solar energy distribution. So it is about design integration, and it is about optimizing a set of building practices and materials that are used in the construction and use of buildings.

The Energy Department certainly plays a role in the research efforts, but a lot of this is taking place in industry. And the NIST role is basically to support industry by developing the basis for model codes and standards that the building industry can use as they develop high efficiency building designs.

Chairman HALL. Okay, is there coordination then with other federal agencies to ensure that there is not duplication—that is one of the things we have more concern with, and to utilize the expertise of the other agencies, I asked why wasn't this work being done by the Department of Energy. I think you have answered that, and I thank you. And I will go to Ms. Edwards, who is the ranking member here, for her five minutes.

Ms. EDWARDS. Thank you, Mr. Chairman, and I know that Ranking Member Johnson would want to be here. And she has asked me to sit in her stead because she has a conflict. Dr. Gallagher, thank you very much for the work that you do, the fine work at NIST. Your headquarters is in Gaithersburg, Maryland in the fourth congressional district. And I want to suggest to Chairman Hall that it would be a great field trip for this Committee to come out and visit the NIST headquarters and laboratories because I know that when I visited, I learned so much. And it makes such a huge difference in terms of understanding the mission of NIST and the work that is done there.

I would point particularly to the Center for Nanoscale Science and Technology, which is doing some of the cutting edge research

in nanotechnologies, cost competitive technologies, that really are the game changer for the future. And so, Dr. Gallagher, thanks, and I look forward to sharing that visit with my colleagues.

I want to ask you in particular about the manufacturing extension partnership. I would just share with you, Dr. Gallagher, that at University of Maryland, the entire University of Maryland system, is in a partnership. It is supported by NIST, and I know that for my state, that partnership makes a huge difference. I mean it is the way that we take some of this really innovative work that is going on at our universities, and we partner with business and transfer those technologies into the marketplace.

And I want to share with you a story from rural Maryland. It is JEM Engineering, and they provide custom antenna design, manufacturing and testing services for government and commercial applications. NIST made—through the partnership, there was a relatively modest investment that has actually resulted in this private firm seeing an increase of $1.2 million in its sales.

Another company in Montgomery County, Maryland, SEMicro Division of METE specializes in design development and manufacturing of adhesive testing equipment. Now, I wouldn't know anything about this, but I do know that when I paint my walls, I want to make sure it sticks. And that is what this company does and what they have been able to do with help through this manufacturing and engineering partnership is to—extension partnership is to develop a technology that allows the use of digital technology converted from analog technology to do testing to make sure that the stuff that we want to stick does. And this has been really important, particularly to the paints and coating industry.

And I know that this company has also seen significant growth in its sales, and it is this kind of partnership that is really the great combination that NIST does in partnering with the business community and transferring technologies and seeing market growth.

In Maryland, I would note that we have seen a real impact of about $291 million across our state from very, very modest investments through this partnership, and I know that is true across the country.

I had a question from my colleague again, Congresswoman Giffords from Arizona, who has been a huge proponent of expanding our manufacturing base. And she notes that, her staff has noted for me that in Arizona the MEP has helped over 300 manufacturers in Congresswoman Giffords' district and in the last five years, increase sales by about $480 million, creating 641 jobs in Arizona. That is something that—it is about 1,400 jobs.

And so if you could tell me please the role that you see from the new budget in terms of the investments that we are making in the MEP program and whether the current budget request really keeps us on track for increasing the partnership to about $180 million by 2015, and the contribution that we anticipate that can make to our manufacturing sector.

Dr. GALLAGHER. Well, I thank you very much for that, and I am delighted to hear the success stories coming from some of the manufacturers that use the MEP program. I think you touched on a couple of critical aspects to remember about MEP. It is a partner-

ship program. The MEP program provides up to one-third of the funding for centers that are across the United States. And what that partnership does is it allows these state-based centers to interact with each other to share and disseminate best practices. And it allows them to share metrics, what specifically works and doesn't work.

And the services that are being provided are services that maybe a very large manufacturing company would be able to do within themselves, but the small business community cannot perform. So this is addressing and matching the capabilities of manufacturers in supply chains with new technologies and new products—helping these small manufacturers operate in what is increasingly a competitive global international market.

If small business manufacturing is the center or the heartbeat of our economic growth, I think it is imperative that a program like this continue. The proposed budget for MEP is consistent with the growth that we have talked about in America COMPETES for strengthening this program that addresses a fairly significant fraction of the small, mid-sized manufacturing base. And I think within that community that is using these services, it is having a very significant impact.

Ms. EDWARDS. Okay, thank you.

Chairman HALL. Thank you, and at this time, I recognize the gentlelady from Florida, Mrs. Adams.

Mrs. ADAMS. Thank you. I want to touch back as something, and then I want to move forward, and I just want quick a response from you as possible. You said that the $13 million that is requested on net-zero research is a stretch goal. At a time when the American people are having to tighten their belts, at a time when our economy is such that people are looking every day for jobs, and we need jobs, we need our economy to improve, do you think it is wise to come and say we want to get $13 million for a stretch goal? Shouldn't we just be prioritizing and working with the other agencies that are already doing this type of investigation and investigative research?

Dr. GALLAGHER. So the quick answer is I think it is wise. Remember the goal is the challenge goal that is in front of them, an interagency effort to develop clean energy technology. So it came out of an interagency study that was started the end of the Bush administration.

Mrs. ADAMS. Do you know how many agencies are doing this study, or are working on this issue?

Dr. GALLAGHER. There are several agencies involved in——

Mrs. ADAMS. Multiple.

Dr. GALLAGHER. —their role——

Mrs. ADAMS. Very multiple. There are millions and millions of dollars.

Dr. GALLAGHER. I don't know the amount, but their roles are laid out in the report.

Mrs. ADAMS. So when you are telling us you are asking for $13 million for a stretch goal, that concerns me. I just want to let you know that because of the economy and the jobs that we are trying to create at this point in time.

I understand the administration has established an initiative known as the National Strategy for Trusted Identities in Cyberspace. The strategy seeks to improve upon the passwords currently used to log in online and enable people to validate their identity securely when they are doing sensitive transactions online. The steps the administration has taken in this area are concerning to me because it is unclear what the trusted identity will look like. Is the administration proposing some central sort of national identification system? And can you explain what the goals of NSTIC are and what tangible output will be produced assuming the initiative moves forward?

Dr. GALLAGHER. Yes, thank you. So NSTIC refers to a national strategy for developing an infrastructure for trust. The strategy is being prepared, and we hope it is released shortly, so that will certainly show more details about what the approach will be. I can share with you that the approach is not to create a centralized identity, government-managed infrastructure. In fact, the reason Commerce——

Mrs. ADAMS. Will you not create that then?

Dr. GALLAGHER. We will not create that. So the purpose is to support industry to develop a variety of technologies that can be used to establish trust between two people having an interaction on the Internet. And our hope is that if industry creates these solutions, whenever the government needs something, we can turn to that.

Mrs. ADAMS. Yes, it is always good to see the private sector working.

Dr. GALLAGHER. We agree.

Mrs. ADAMS. In early 2009, the National Academies published a report titled "Strengthening Forensic Science in the United States: A Path Forward." The report detailed many concerns with the state of forensic science in our country, and the reliability and accuracy of the science behind techniques and procedures used to convict or acquit people of crimes was called into question. Could you please discuss what NIST's role has been in forensic science, and what you think the appropriate role for NIST should be in the future?

Dr. GALLAGHER. Thank you. I think the historic role for NIST is its core mission, which is the nation's measurement laboratory. So the activities we have had in forensic science are to establish a scientifically validated methodology for specific types of measurements. From the beginning of NIST's history, we have been involved in forensic science measurements.

The specific example that is noted most often is our role in establishing the methodology for DNA matching, which is, of course, used extensively. In fact, that was pointed out in the Academy's report. So I think the correct role for NIST is to not be a judicial agency, but to actually focus on the measurement science and to provide a validated basis for techniques that are used in the field.

Mrs. ADAMS. So that is——

Dr. GALLAGHER. That has been our effort.

Mrs. ADAMS. Thank you. And also I am quickly going to ask about the manufacturing I have heard from some in the district. That there doesn't seem to be an understanding from our President about the importance of the industry to the future of American in-

novation. Do you feel there is leadership on this issue, and how is the administration coordinating manufacturing activities amongst the different federal agencies?

Dr. GALLAGHER. So I have an enormous passion for manufacturing because our ability——

Mrs. ADAMS. As have I.

Dr. GALLAGHER. —as a country to innovate depends on our ability as a country to manufacture. 70 percent of the scientist and engineers in this country work for manufacturing industries. So our capacity as a country to innovate is fundamentally tied to manufacturing.

I think that there is a window of opportunity. I think there is an enormous sense that, in fact, everyone is getting it. I think everyone understand the importance of this. The highest levels of the administration are now focused——

Mrs. ADAMS. They are now focused on it? Thank you.

Dr. GALLAGHER. And there is a very robust interagency process to——

Mrs. ADAMS. Well, as someone who worked in the manufacturing business years ago as a teenager and watched it all disappear, I would love to see it all come back.

Dr. GALLAGHER. I would love to work with you on that.

Mrs. ADAMS. Thank you.

Dr. GALLAGHER. Thank you.

Chairman HALL. I Thank the gentlelady. The Chair recognizes Mr. Sarbanes from Maryland for five minutes.

Mr. SARBANES. Thank you, Mr. Chairman. I appreciate it. Thank you for being here, Dr. Gallagher. I appreciated your taking the time the other day to brief me on this. I had some understanding of it. I have a much deeper understanding and appreciation of the work that you do and how critical it is to the innovation agenda for our country.

If you were here during the earlier panel, which I believe you were, you heard me hammer on this theme of rebuilding the country and how that is something that Americans understand implicitly. What is involved in that is really investment in all different kinds of infrastructure, physical infrastructure, human infrastructure, civic infrastructure. A lot of the work that NIST is doing is powering innovation and technology. And I too want to commend NIST for the MEP program and for the Manufacturing Extension Partnership and all that that means, particularly for small businesses who may not have the resources on their own to bring in new, innovative, cutting-edge techniques but can draw on the expertise that is assembled through the MEP program.

And I hope that at the end of this budget process, the resources that you would like to see committed to sustaining that effort are there to help that, the mission of that program.

You mentioned the other day when we met and I thought you might address it in the hearing briefly, this idea of establishing sustainability standards. Obviously one of the principal roles NIST has is to create these standards that can cut across, and also to think about how our standard setting interacts with the standard setting that goes on around the world and make sure that we are

at the table as that is happening, that we are exercising a leadership role where that is appropriate and useful to do.

And I was impressed to hear that the United States' standard setting process is really the gold standard internationally. Could you speak to the efforts to kind of push and work with industry to develop these sustainability standards? Before, as I gather, others have done so because I don't think that has been established elsewhere yet. And if we could get on the front edge of that, that would be really helpful, I think.

Dr. GALLAGHER. So thank you. All right, the standard setting in the United States is actually unique around the world because standards are set by the private sector. Industry leads our standards development efforts in the United States. NIST's role by law is to coordinate the federal agencies' interaction with the private sector standards.

In the area of sustainability, it is quite interesting because consumers have always attached value to what a manufactured product is. And so obviously we are sensitive to price. That reflects how efficiently something is made, but we also are concerned with the quality of how something is made. In the 1980s, we were very concerned about the quality of American manufactured products.

Increasingly, there is this sense of caring about the life cycle of a manufactured product because of finite resources. So whether it was officially made using either natural materials, including the recyclable costs or the recovery costs when the useful lifetime of that manufactured product is done, whether it is the use of energy in manufacturing that process.

And other parts of the world are actually addressing these and in some cases, making requirements in their marketplace about whether hazardous materials of a certain type will be used or certain types of energy efficiency.

U.S. manufacturers are coming to NIST because they see the strategic advantage of having their products be identified as sustainably manufactured. And for consumers to attach value to that, we have to help define what that means, and so this is a classic case of NIST working with industry to help define what—how do you define sustainability, and what the voluntary consensus standards are around that.

My feeling is that consumers will attach value to this, and as they do, that will strongly advantage U.S. manufacturers because many of the attributes of manufacturing in the United States with our energy infrastructure and our environmental approach re-advantages manufacturers in that context.

So it is critically important. This Committee has recognized that it was called for under the America COMPETES reauthorization, and we have tried to reflect that in our request. It is critically important.

Mr. SARBANES. Thank you.

Chairman HALL. Thank Mr. Sarbanes, and now we recognize the gentleman from Arizona, one of our new Members, Mr. Quayle, for five minutes.

Mr. QUAYLE. Thank you, Mr. Chairman. Dr. Gallagher, good to see you again.

Dr. GALLAGHER. Yes.

Mr. QUAYLE. Thanks for coming. One of the things I wanted to talk to you about is health IT, and one of the things that has been coming up a lot is electronic medical records and how we can actually probably be able to reduce injuries and mistakes and also reduce costs because a lot of times, we repeat and duplicate procedures that aren't needed.

But one of the things that I have been talking to doctors back in my home district about is that there are so many different types of electronic medical records, and they are not compatible with one another. And so what happens is that it is much easier and much quicker for them to actually just go and do the same procedures over again.

So we are starting to have a lot of electronic records that can't communicate with one another. And we are just duplicating the same problem that we had before. So I wanted to know how have you at NIST been able to deal with the huge laundry list of various health IT standards in trying to make sure that there is one set way that electronic medical records can communicate with one another?

Dr. GALLAGHER. Thank you very much. It is critically important, and I think you enunciated the advantages of information in medicine, that the efficiencies we can gain are extremely large. The challenges are large too because if this information can't be officially shared, protecting the security so we don't violate the privacy of patients, that it is used appropriately, then this system doesn't work.

By law, the responsibility for fostering the creation of a national not interoperable system of health care records was given to HHS, and they have an office of the national coordinator that is led by Dr. David Blumenthal. NIST works extremely closely with that office, and, in fact, that role was also laid out by legislation.

The best way to understand the NIST contribution is that, as a nonregulatory, technical agency, our job is to work both with the industries that are developing these electronic medical systems and with HHS, the federal agency that creates the incentives through Medicare/Medicaid reimbursements that are set out by law, to make sure that when we set requirements or standards for these products that they are testable and achievable.

So a key part of the NIST role is how do you show that two systems can share information and that the information will be accurately and securely conveyed? So a key part of the NIST role is its technical work to find a testable test methods, validation methods. How would you demonstrate the two systems can talk to each other securely and reliably? And then working with HHS to support how they help the market. In other words, how do you help a physician, who is buying a system, know that the system he is buying will work in this national network? And that it could come down to product identification or some sort of voluntary certification process.

NIST has experience with a wide range of those processes, and so we provide guidance there. These are called conformity assessment techniques. How do we show in the market that something complies with these standards that industry has come up with?

Mr. QUAYLE. And in the private sector, those that are dealing with electronic medical records, have they been helpful and open to having some set standard in terms of being able to communicate? Obviously each different product will have different bells and whistles, but having the ability to have one set standard so that they can communicate, whether one doctor uses one product and the other uses another. Have they been open to that?

Dr. GALLAGHER. Very open. So from the marketplace, if I am a company producing these kinds of products and services, this is to my advantage now because there is no way I am going to capture the whole market where everybody buys my system. So what I want is to make sure that the products I am selling, the physicians and doctors' offices and hospitals buying it know that it will work in this national network. It basically creates a platform technology that they can then build on, and they can distinguish themselves, not on whether it works—that is now sort of a core functionality—but what additional features their products and services offer.

So it provides a real platform on which they can go forward, and they have been very cooperative. In fact, it is industry that takes the lead in defining many of these requirements. We are the technical resource for them and play a key convening role. How would you demonstrate that these requirements that you are proposing would work, and how would we show it through tests and other techniques?

Mr. QUAYLE. And is one of the big requirements going to be, or is it in the process of being basic cybersecurity because of the delicate nature of medical records to make sure that they don't get in the wrong hands? Is that being addressed in——

Dr. GALLAGHER. It is critically important because you are talking about sharing information, very sensitive information about patient and physician basically through the Internet. And we don't want to violate patients' privacy. We don't want anyone compromising these records or destroying them because we are literally dealing with peoples' lives here, and so the cybersecurity is a critical attribute of a successful electronic medical records system.

Mr. QUAYLE. Okay, thank you, Dr. Gallagher. I yield back.

Chairman HALL. Thank you for that. Chair now recognizes Mr. Wu for five minutes, and your time is almost up, Mr. Wu.

Mr. WU. Mr. Chairman——

Chairman HALL. Since you are a member of the Committee, we recognize you for your five minutes.

Mr. WU. Mr. Chairman, you have always appropriately kept me on a correct length leash. Thank you. Thank you very much for being here, Dr. Gallagher. You are a very capable leader for a very important agency. My three-part description of NIST has always been if you can't measure it, it is not real for economic or technical purposes. If you don't have a reference material for it, you don't really know what it is. And if you don't have technical standards, then it is potentially interoperable, and you run the risk of a technologic tower of Babel.

Your agency is absolutely crucial to our technology and to our economy and to American innovation. I am here today to ask you about a very prosaic, very practical matter that has been forcefully brought to our attention by the tragedy in Japan this morning.

These earthquakes, the earthquake in Japan, and we certainly extend our heartfelt condolences to all the Japanese who have been affected by this and those who are currently here in the United States.

This kind of tragedy has also struck Chile and Haiti in the recent past. It is also something that is very much on my mind because a similar phenomena will occur off the coast of Oregon. The Cascadia Fault runs off the Washington, Oregon, and California coasts, and of particular concern is a 250-mile stretch of the Cascadia Fault that is currently locked up. Historically it has locked up, and every 300 years or so, there is an earthquake of up to 9.0 magnitude right in the range of the 8.9 Richter Scale magnitude that occurred in Japan this morning. The fault is also close to the Oregon coast, like the Chilean fault earlier this year and like the Japanese fault.

NIST is taking a leadership role in setting standards and doing cutting edge research on structures, buildings, and other infrastructures, which are resistant, better resistant, to earthquakes. I would like you to talk a little bit about that, and then I have one quick follow-up question after that.

Dr. GALLAGHER. Great, thank you. And it is tragic that this is such a timely topic today. Many of our colleagues and friends from Japan were waiting to hear how things are faring with them. So the relationship with NIST and hazard reduction for earthquake hazards goes back to 1977 when Congress passed the National Earthquake Hazard Reduction Act. In that process, several agencies have critical responsibilities. There are four major agencies: NIST, the U.S. Geologic Survey, FEMA, and the National Science Foundation. They are working with the Office of Science and Technology Policy.

The roles complement each other, so USGS looks at seismic research and how you predict and map out hazard areas. FEMA looks primarily at response and recovery activities, and NSF supports the long-range engineering research that we need to help engineers design seismically-resistant structures and the NIST role is quite interesting.

The NIST role is to support the development of infrastructure and buildings that are resilient against earthquake hazards. And the way we affect that is understanding how buildings are built. That is when you design in how resistant a building is to a hazard. So the most critical thing you can do is take the research results that these larger efforts are doing, plus what we learn when an earthquake happens, and make sure we are reflecting the latest understanding in building codes.

The Federal Government doesn't set building codes. What we do is work with the codes community to develop model codes, and those are adopted at the local level. So the NIST role is interesting because we have to learn from tragedy: so one of our roles is to use the field as experience, figure out why structures fail under earthquake or other natural disasters, and also look to what the research community is telling us, and then work with the standards and codes community to reflect that.

And I think the advisory committee for the Earthquake Hazard Reduction Program is actually at NIST. Yesterday and today, I will

be meeting with the committee as soon as I leave here, and I think they would tell you we have a balance of the portfolio problem. That we, while we have very strong efforts in the recovery part of our—the emergency recovery part of our portfolio. We are not spending enough on the hazard mitigation or the risk reduction piece.

And that includes not just the buildings themselves but also the infrastructure. If you lose power and natural gas and water the ability of a community to respond is severely compromised, and so these lifeline issues are critically important. And this is also reflected in our request.

Mr. WU. Doctor, the Chairman will forcefully say that my time has expired, so let me ask this question and ask for your answer later. And my understanding is that different building codes, different nations, the Chileans, the Japanese, some of them have had remarkably resilient buildings, and I would like to know how the United States compares to some of these other countries when you have time to respond, not during Committee time. Thank you very much.

Dr. GALLAGHER. Thank you.

Chairman HALL. Thank you, Congressman Wu, and thank you, Dr. Gallagher, for your very direct and professional answers. We appreciate it. Thank all those of you still here in attendance. And Members of the Committee may have additional questions that they will submit to you. We ask that you answer those in writing. If you can, we would like for you to do it within the two weeks time if that is possible. The record will remain open for two weeks for additional comments. The Members and witnesses are excused. I thank all of you for coming. The hearing is adjourned.

[Whereupon, at 1:27 p.m., the Committee was adjourned.]

Appendix I:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Subra Suresh, Director, National Science Foundation

Questions submitted by Representative Ralph M. Hall

Q1. Scattered throughout the entire federal budget request are dramatic increases in spending on "clean technologies." At the Department of Energy alone, there are enormous spending increases for clean tech through ARPA-E, EERE, the Office of Science, the Loan Guarantee Program, and Energy Innovation Hubs, to name just a few. Similar programs are proposed throughout the government, including NSF's "Science, Engineering, and Education for Sustainability (SEES)" portfolio intended to "spark innovations for tomorrow's clean energy sources with a cross-disciplinary approach to sustainability science." The FY 12 budget request is $998 million for this effort. This is a 51 percent increase over the FY 10 amount and reflects 13 percent of the entire NSF budget.

a. Given that President Obama said in the State of the Union that he was "willing to eliminate whatever we can honestly afford to do without," and the immense amount of spending across the federal government on clean energy activities, do you really believe the NSF can't "afford to do without" this $338 million in new spending on this one topic?

b. Further, is it even possible for NSF to responsibly absorb and spend such dramatic increases in funding? How is NSF working with the Administration to ensure that there is a government-wide coordinated research strategy, with specific, government appropriate research to confined areas? How can you prevent "research crawl," when identical research proliferates into every agency? How can you assure us that the research NSF is supporting is not identical to the research being supported by the plethora of other agencies performing similar research?

A1a. NSF's involvement in clean energy is driven by the fundamental research questions that underlie future energy pathways. NSF's investments in clean energy support research and education in alternative energy for electricity (solar, wind, wave, geothermal) and fuels (chemical and biofuels). NSF grantees also address the collection, conversion, storage and distribution of energy from diverse power sources (including smart grids), the science and engineering of energy materials, energy use and energy efficiency. As an integral part of the NSF Science, Engineering, and Education for Sustainability (SEES) portfolio, clean energy research addresses our advancement toward reliable and sustainable energy resources that will not degrade essential ecosystems and environmental services, not lead to unacceptable social or economic consequences, and will prepare society to responsibly adopt them.

In FY 2012, the SEES activity, which is designed to advance science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being, is proposed to include a major emphasis on sustainable energy. NSF will mobilize the social, behavioral, and economic science research community to work in close collaboration with natural scientists and engineers to provide a comprehensive and integrated approach to solving questions of sustainability. NSF views this investment to foster insights into the environment-energy-society nexus as vital to increasing the effectiveness of our energy and ecosystem management policies, and to securing a prosperous future for the Nation.

Future U.S. economic competitiveness, energy independence, and sustainable growth greatly depend upon a talented and motivated workforce with strong competencies in science and engineering. NSF's long track record of supporting the development of creative faculty, and their students, form the backbone of the Nation's strength in science, technology, engineering, and mathematics. These faculty and students go on to be the leaders in efforts supported by other agencies such as the Department of Energy (DOE), entrepreneurial start-ups, and large companies. NSF's integration of research and education is vital for the future of the country. Specific efforts under SEES will support postdoctoral researchers and early career scientists at the interfaces between social sciences and engineering disciplines so that they might gain the skills necessary to address critical scientific and societal challenges.

A1b. NSF funds research that is performed external to the government and across traditional disciplinary lines. This approach to research is critical to address highly complex areas, such as the environment-energy-society nexus, where disciplinary boundaries need to be broken to solve seemingly intractable problems and enhance energy independence.

Last year some $2 billion in funding requests that were judged to be meritorious and worthy of support were declined due to unavailability of sufficient resources.

Initial SEES activities in 2010 and 2011 were significantly oversubscribed, demonstrating the tremendous need for investment in this area, and the requested S338 million increase in SEES would support approximately 700 typical NSF research grants. Importantly, the complex nature of the environment-energy-society dynamic will, in many cases, best be understood through the coordinated work of teams of investigators and require research at multiple organizational, spatial, and temporal scales. Funding these teams will require support at levels above the NSF average.

The issue of possible duplication of effort across agencies is important to NSF. Our activities in the sustainability arena are developed in close consultation with DOE, NOAA, USGS, USDA, and other federal agencies to specifically leverage, not duplicate. federal investments. Already, DOE partners with NSF in Engineering Research Centers focusing on the engineering, science, social science, economics and human behavioral aspects associated with disruptive changes in energy strategies. Discussions with other federal agencies indicate considerable interest in building joint programs and sharing infrastructure. Leveraging these programs internationally is also important to meet sustainability challenges. The proposed SEES activity explicitly includes support for networks of diverse investigators in order to optimize collaboration and reduce duplication.

NSF is a key player in the inter-agency sustainability arena because of our unique involvement with all the areas of science, engineering, and science education required to address the complex system level problems of sustainability. As the only agency specifically dedicated to advancing fundamental scientific and technological understanding across all science and engineering fields, NSF-supported research typically precedes direct application by mission agencies or others by years to decades. In addition to closing key knowledge gaps about the interplay of environment, energy, and society, NSF will link the academic community with private partners to address sustainability issues and educate the next generation interdisciplinary workforce. Here is how NSF SEES sets us apart from the other agencies and plays to our strengths:

- NSF has developed a "pathways approach" to SEES. This approach involves cross directorate and interdisciplinary research that integrates the physical, engineering, social, and environmental sciences to provide a comprehensive and integrated approach to solving questions of sustainability.
- Our "sustainable energy pathways" integrates resource characterization and the technology needed to develop and effectively use the resource with the social and environmental impact of widespread adoption of that energy source.
- NSF will invest in graduate students and postdoctoral scholars with the aim to develop a scientific workforce trained in new technologies for emerging markets in energy and other aspects of sustain ability science.
- NSF uses a total systems approach to the sustainability challenge that involves cutting edge science and technology coupled with a strong commitment to education and training. National Nanotechnology Initiative /NNI)

Q2. The budget request calls for a 10.6 percent increase for the NSF contribution to the National Nanotechnology Initiative (NNI). Please tell us how this increase of funding will be spent and why it is necessary at this time?

A2. The NNI investment at NSF will focus primarily on priority areas driven by national needs (manufacturing, electronics, and energy), public safety (nanotechnology environment, health and safety (EHS)), and partnerships with other agencies (NNI-NSTC crosscuts) and industry.

BA portion of NSF's NNI investment, $117.40 million, will be invested in three NNI Signature Initiatives (partially covered by the requested increase in addition to the reallocation of funds within the current budget)

Sustainable Nanomanufacturing ($35.40 million): This request will support single investigator and interdisciplinary research teams in the following areas:

- Novel processes and techniques for continuous and scalable nanomanufacturing;
- Directed (physical/chemicallbiological) self-assembly processes leading to heterogeneous nanostructures with the potential for high-rate production;
- Principles and design methods to produce machines and processes to manufacture nanoscale structures, devices and systems; and
- Long-term societal and educational implications of the large-scale production and use of nanomaterials, devices and systems, including the life-cycle analysis of such nanomaterials, devices and systems.

Partnerships with NIST, DOD and other NNI agencies are planned.

Nanoelectronics for 2020 and beyond ($50.0 million)—This request will fund grants to advance the forefront of computation, information processing, sensor technologies, and communications infrastructure beyond the physical and conceptual limitations of current technologies. The initiative is intended to support proposals by single investigators and interdisciplinary teams of investigators committed to exploring innovative research concepts in nanoelectronics involving fundamental challenges from novel materials, chemistry, and logic devices, to circuit designs and systems architectures, algorithms, and perhaps entirely new paradigms of computation, sensing, and processing of information. The following themes will receive priority:

- Exploring new chemistries and materials for nanoelectronics;
- Exploring alternative state variables and heterogeneous integration for nanoelectronic devices and systems; and
- Exploring novel paradigms of computing.

Co-funding with the Semiconductor Research Corporation and other NNI agencies is planned.

Nanotechnology for Solar Energy Collection and Conversion ($35.40 million). This request will fund single investigators and interdisciplinary research teams in the following areas:

- Improve efficiency of photovoltaic solar electricity generation with nanotechnology;
- Develop thermoelectric converters for solar thermal energy generation and conversion with nanotechnology; and
- Improve solar-to-fuel conversions with nanotechnology.

NSF will collaborate with DOE and other NNI agencies.

Environmental, Health and Safety (EHS). In FY 2012, funds are transferred from several Program Component Areas (PCAs) to increase funding for the Environmental, Health and Safety (EHS) PCA to reach a total FY 2012 funding level of $34.51 million. This shift reflects the prioritization of EHS within the overall NNI portfolio. Requests for research are primarily directed at environmental, health, and safety implications and methods for reducing the respective risks of nanotechnology development. The support for EHS represents 7.6 percent of total NNI funding at NSF.

The three signature initiatives and nano-EHS research increases have been recommended by interagency working groups, workshops organized with the research communities and the President's Council of Advisors on Science and Technology (PCAST). In addition, NSF sponsored an international study entitled "Nanotechnology Research Directions for Societal Needs in 2020" (NSFIWTEC report in 2010, available on www.nsf.gov/nano.) It provides assessment of nanotechnology development over the last ten years (2000-2010) and a long term vision of the field over the next decade (2010-2020).

MREFC

Q3. As you are well aware, the recently passed House Continuing Resolution reduces funding for the MREFC account significantly. Should that amount become law, please describe how NSF will distribute the funding across current projects.

A3. If expected funding levels are not appropriated in FY 2011, NSF will give priority to completing projects in construction—with highest priority to those farthest along. NSF plans to minimize the disruption to the portfolio of projects in construction by making budget alterations to the smallest number of projects necessary to stay within the available budget. For early phase construction projects and new starts, NSF will assess their plans to see where funding reductions would produce the least impact on project performance and risk, and result in the best overall outcome under the circumstances. Changes to the proposed funding plans—which were based on technically limited cost profiles (i.e. expenditure profiles based on planning projects at the maximum rate technical work can be performed because that profile provides the lowest total cost to the government)—could result in net increases to the total project costs of each of the projects affected. NSF is quantifying these cost impacts and will make adjustments to the proposed distribution across the portfolio of projects based on an understanding of the costs of various options.

Questions submitted by Representative Mo Brooks

Budget Priorities

Q4. Could you please identify and explain the processes and criteria used to establish the priorities for NSF in the FY 12 Budget Request?

A4. NSF establishes scientific priorities based on a myriad of inputs and considerations, To ensure that NSF's research funding is focused on the needs of the scientific community, the agency takes seriously the important feedback obtained through workshops, Advisory Committee meetings, outreach efforts, and everyday interactions between NSF program staff and their peers and colleagues in the science and engineering community, In addition, the Foundation closely follows guidance and priorities identified by OMB and OSTP in official documents, such as the annual joint memorandum on Science and Technology Priorities, and statutory requirements and other Congressional priorities.

High-level planning begins early in the budget cycle and is a highly collaborative and evolutionary process, NSF's senior management team, which represents all directorates and offices, works closely together throughout the planning stages to brainstorm, share, build, and refine their ideas, Ultimately the NSF director, in concert with the National Science Board, determines NSF's strategic budget directions.

Q5. The Administration's Innovation Strategy details its efforts to strengthen our nation's competitiveness and long-run economic growth. What role does the Foundation and Board play in measuring and evaluating the economic impacts of basic research funding? What methods does the Federal Government use to prioritize funding areas of basic research, both within an area of science and across areas of science?

A5. The National Science Foundation (NSF), including the National Science Board (NSB), undertakes a number of actions that inform government, industry, and academic officials about the economic impact of basic research funding, The Science and Engineering Indicators report, issued biennially by NSS, provides a broad base of quantitative information on the U,S, science and engineering (S&E) enterprise including: patents awarded (e,g" academic patents awarded per 1,000 S&E academic doctorate holders); scientific publications (e,g" academic S&E article output per $1.0 million of academic research and development (R&D)); investments in R&D (e,g., academic and federal R&D obligations as share of gross domestic product); and trends in R&D performance and international R&D comparisons (e,g., "wealthy economies generally devote larger shares of their gross domestic product to R&D than do less developed economies "). In addition, NSF's Science of Science and Innovation Policy (SciSIP) program invests in research designed to develop, improve, and expand models, analytical tools, data, and metrics that can be applied in the science policy decision making process, Among the research topics supported under the SciSIP program is the evaluation of the tangible and intangible returns from investments in science and in research and development. Retroactive impact assessments (including research-submitted highlights) also enable NSF to measure and evaluate the impact of its investments. Methods used by federal agencies—including NSF—to prioritize basic research investments include: Administration-identified national challenges, the OMS-OSTP R&D priorities, National Science and Technology Council deliberations and decisions, Congressional authorizations and budget allocations, and input from the U.S. research community though NSF advisory committees and other mechanisms such as the President's Council of Advisors on Science and Technology.

Q6. The NSF FY 12 Budget eliminates and reduces several programs across the Directorates, but does not go nearly far enough in my opinion. At the same time, several new programs are being created and many directed programs are receiving increases. I am concerned that while programs like the Graduate STEM Fellows in K-12 Education and the National STEM Distributed Learning Program are on your list because evaluations have shown that they are not necessarily proven programs, it seems that NSF is simply looking to shift those dollars (and more) into new, unproven programs. Can you explain the decision-making process for the terminations and reductions as well as the creation of the new programs? Is the scientific community driving these decisions or is the Administration?

A6. NSF undergoes a continual portfolio assessment process in order to ensure that investments are closely aligned with agency priorities and at the leading edge of science and engineering. The Foundation uses its evaluation processes to identify where the potential might lie for more innovative and effective investments.

The six terminations and reductions proposed for FY 2012 reflect this ongoing process of review and reprioritization. A number of these were informed by recent program evaluations, while others reflect findings from major reviews by the National Science Board and other key stakeholders.

Q7. The word "new" appeared 34 times in your testimony and 17 times in Dr. Bowen's. Most of these references were to new programs or initiatives. In light of our current economic reality, when the American people are begging us to change our spending habits and resources are precious, why is it necessary to begin new programs? Can you provide a better justification for the creation of these new programs mentioned in your testimony, especially those that seem to duplicate existing programs, such as Teacher Learning for the Future, and Transforming Broadening Participation through STEM?

A7. To effectively transform the frontiers and innovate for society, NSF engages in a dynamic and ongoing process of strategic realignment and refinement of program emphases. To do so requires phasing out programs that have met their goals, while preserving the key elements of those programs in new formulations that anticipate future needs. These realignment and refinement decisions are based on a range of factors, including key national reports, input from the research and education communities in schools and universities, input from NSF's advisory groups, evolving collaborations with other agencies such as the U.S. Department of Education (ED), and analyses of evidence growing out of NSF's funded portfolios.

The proposed Teacher Learning for the Future (TLF) and Transforming Broadening Participation through STEM (TBPS) programs do not duplicate existing programs. Instead, they will build on the lessons and successes of current programs, and will draw heavily on recent research and synthesis studies, to catalyze needed innovations and new models in two areas that are essential for progress in improving STEM education: the effectiveness of STEM teaching, and the recruitment, development, and retention of a broadly diverse STEM workforce that includes people from all groups traditionally underrepresented in STEM, including women and persons with disabilities. These two programs will challenge NSF grantees to transform the frontiers of education and innovate in ways that are critical for society.

Q8. I understand and respect that, as mentioned in hearing testimony, "neglecting scientific research and education now will have serious consequences for the future of our country." However, Congress is faced with many difficult funding decisions in our current economic situation. Every Committee is hearing similar pleas from education to transportation and from energy to defense. Federal funding cuts are a likely reality over the next few years. How would you suggest we look at reigning in government expenditures across the board? How do we prioritize programmatic funding for the Foundation?

A8. The President's budget for FY 2012 identifies a path to restrain spending overall while also protecting essential investments in the Nation's future. The Foundation's vital role has been recognized in significant ways: The President's Plan for Science and Innovation calls for doubling the federal investment in key basic research agencies, including NSF; and the America COMPETES Reauthorization Act of 2010 acknowledges that "the National Science Foundation is the finest scientific foundation in the world, and is a vital agency that must support basic research needed to advance the United States into the 21st century." Consistent with this, NSF's FY 2012 Budget Request capitalizes on promising research areas where new discoveries can help regain U.S. competitiveness and leadership in the science and engineering enterprise.

Q9. Dr, Bowen identified NSF as the "only federal agency dedicated to the support of basic research and education in all fields of science and engineering." Are the more applied areas of research identified in the America COMPETES Reauthorization Act, coupled with many Administration applied priorities for NSF in the FY 12 budget request diluting the funding for basic, fundamental research? Please explain your response.

A9. This is not the case. Congress and the Administration recognize the importance of funding basic, fundamental research, and the FY 2012 Request strengthens these investments.

The 2010 Act recognizes that NSF, as the only federal agency dedicated to fundamental research in all fields of science and engineering, supports advances that lead to downstream applications. For example, in manufacturing research, such as nanomanufacturing and advanced sensing and control techniques, NSF's contributions will be in "fundamental research leading to transformative advances in manufacturing technologies, processes and enterprises that will support United States

manufacturing . . .” The 2010 Act also recognizes that NSF can play a key role in developing collaborations “that promote innovation and increase the impact of research by developing tools and resources to connect new scientific discoveries to practical uses.”

STEM Education

Q10. The Administration plans to invest $3.4 billion across the federal government for STEM education, including many new initiatives primarily at the Department of Education. While the Department of Education should certainly take a more active role in STEM, do you know what the rationale is for shifting this support from NSF to Education? How actively involved can NSF be in decisions being made at the Department of Education on STEM-related issues? What steps are being taken to ensure that these new activities are research-based and will have input from not only the education community but also the scientific community?

A10. NSF continues to play the leading role across federal agencies in advancing and improving K-12 science, technology, engineering, and mathematics (STEM) education, through the design, creation, implementation, and study of models, approaches, and instructional materials for STEM student learning, and through investment in ensuring effective STEM teaching through teacher preparation and development. Building on its past accomplishments and anticipating the future, NSF is uniquely situated among federal agencies to advance this kind of education because of its strong connections with the Nation’s leading STEM researchers, faculty, education researchers, science, technology, and education policy makers, and other professionals.

NSF programs supporting STEM education encompass a wide range of disciplines, including biology, chemistry, engineering, mathematics, physics, computer science, social science, economics, behavioral science, geological sciences, Arctic and Antarctic studies, and a range of interdisciplinary areas. Among federal agencies, this immediate access to such a broad range of cutting-edge science for activities in K-12 education is unique. Complementary programs at other agencies focus on mission-oriented areas of STEM. This unique NSF context allows for an investment that is STEM education-specific and that complements the more general and wide-ranging investments of the U.S. Department of Education (ED). The Administration’s request does not signal a shift of support from NSF to ED. Rather, it conveys the more deliberate complementarity of the two agencies’ investments resulting from very strong communication and coordination activities that have been underway between the two agencies over the past two years. Currently, there is a working group comprised of NSF and the Institute of Education Sciences (IES) staff developing common “evidence standards” that will serve as a basis for both NSF and ED STEM programs.

Q11. Everyone touts the importance of America COMPETES and the America COMPETES Reauthorization Act, but rather than sticking to funding proven and established programs at NSF like Noyce Scholarships and the Math and Science Partnership (MSP), the FY 12 budget request reduces their funding by $20 million in order to create a new teacher development program. The Noyce program was expanded in the original COMPETES Act to include a new program called 10,000 Teachers. 10 Million Minds. The FY 12 budget is now calling for a NEW 100,000 STEM teachers program with the same hoped for end result. Other than the focus being at the Department of Education versus NSF, do you have any idea how this new program will be different? Is there a problem with the program currently in place at NSF?

A11. NSF’s MSP program is a broadly defined research and development program aimed at improving K-12 student learning in the STEM fields. There are a number of strategies and approaches funded in this program, including teacher professional development; strong engagement of STEM faculty; efforts to work with standards, frameworks and curricula; and, to some extent, efforts to improve teachers’ preservice preparation. Evaluation evidence indicates that MSP is effective in building professional learning communities and, in particular contexts, raising student achievement. The Robert Noyce Scholarship (NOYCE) program is primarily a scholarship program, and the program evaluation being launched at this time will include examining the impact of Noyce scholars on their students’ learning. Neither of these programs is explicitly focused on building the research knowledge to support the innovation and improvement needed in teacher preparation to prepare 100,000 new STEM teachers who will be effective in ensuring student learning of tomorrow’s complex STEM content.

NSF's proposed TLF program would likely attract applications from PIs who have become involved in teacher preparation research on the basis of their implementation experiences in MSP and Noyce, and would allow a focused and rapid development of learning about quality teacher preparation that would serve as the foundation for the larger scale-up activity proposed by the Department of Education.

Q12. A few weeks ago, the new National Science and Technology Council STEM Education Committee convened. Please describe the role NSF will play in this Committee. Do you think it will be able to effectively identify duplicative and ineffective STEM programs across the federal government? And if so, how and what actions can be taken to save the American taxpayer from continuing to support these programs?

A12. NSF Director Subra Suresh, together with OSTP Associate Director Carl Wieman, serves as co-chair of the newly constituted STEM Education Committee (Co-STEM). Work is already well underway in two task groups—Federal Inventory of STEM Education (FI-STEM) Task Force and the Strategic Plan Preliminary Task Force. Dr. Joan Ferrini-Mundy, NSF's Assistant Director for Education and Human Resources, is the NSF representative on both of these task groups. The inventory group has already created a draft template for gathering relevant information about STEM programs, including information about effectiveness and metrics, and has begun collecting the relevant information. This inventory will serve as a key foundation for the Strategic Plan group. NSF is confident that the kind of deliberate planning for complementarity and interfacing of programs that has been started between the NSF and the Department of Education can serve as a model that can be expanded to ensure appropriate complementarities and coordination among other agency programs. We do anticipate that this may require the realignment and refocusing of several programs across agencies.

Broadening Participation

Q13. NSF is proposing to eliminate funding for the Research Initiation Grants to Broaden Participation in Biology program (RIG) because "the number of proposals from underrepresented groups did not increase." Is this the same case for other broadening participation programs within the Foundation? What evidence do we have that these programs are achieving the desired results? Why do we need yet another new $20 million "Transforming Broadening Participation through STEM (TBPS) program?

A13. After the introduction of the Research Initiation Grants to Broaden Participation in Biology program, the number of Biology principal investigators from underrepresented groups did not increase. Consequently, the Biological Sciences Directorate is evaluating its strategy for broadening participation and discussing a different model to reach the goal of increasing competitive regular research proposals from underrepresented groups. Every NSF Directorate goes through a similar analytical process with respect to its programs, and NSF's Priority Goal for STEM workforce development focuses on establishing evaluation that will inform program improvement for more strategic impact. NSF's Transforming Broadening Participation through STEM program would take advantage of new possible emphases and partnerships, based on continued understanding of best practices and needs. At the undergraduate level, recruitment and retention of students from groups traditionally underrepresented in STEM is an especially serious challenge. TBPS would invest in strategies to place exciting and substantial access to cutting-edge science at the center of efforts to recruit and retain students; none of the current HRD programs at the undergraduate level has this particular focus as the main strategy.

Questions submitted by Representative Randy Neugebauer

NEON

Q14. Your FY 2012 budget request includes $224.7 million for the Major Research Equipment & Facilities Construction program (MREFC), which is an increase of nearly 92 percent over FY 2010 levels. A large chunk of this funding would be applied to the second year construction of the National Ecological Observatory Network (NEON), which will collect data across the U.S. on the impacts of climate change, land use change, and invasive species. What assurances can you provide and what practices and safeguards will be put in place in NEON to ensure that scientific objectivity will not be compromised in favor of more agenda-driven research practices?

A14. NSF-supported fundamental science assures an objective science baseline upon which managers and public officials can make sound decisions that impact the health and welfare of this country, and from which the R&D enterprise can provide the innovations that drive U.S. industry and business.

The NSF review processes both for MREFC project planning and oversight and basic merit review for individual science projects are highly structured with inherent safeguards. The MREFC process includes "Guidelines and Design Review Processes" that define the practices, processes, and criteria for the design, construction, and operations of all NSF Large Facilities. The MREFC process evaluates the scope, scientific and technical requirements, cost, and schedule. Using expert panels, Directorate evaluation, and the Directors Review Board, the scientific conceptual design, project execution, management, and operations plans are evaluated. This includes approval by numerous external review panels (that include cost analysts and engineers), internal review, and approval by the National Science Board. NEON has been through all stages of these processes and has been certified at all levels as a scientifically-sound and well engineered construction project with carefully reviewed and certified cost and schedule.

Scientific objectivity has been at the center of the NEON design and deployment at all stages of the project development. Infrastructure will be deployed to advance our understanding of the biosphere at regional to continental scales. The science requirements, the design and construction plans and processes, and maintenance and operations plans have been vetted by thousands of scientists and engineers.

Questions submitted by Representative Sandy Adams

STEM Education

Q15. As mentioned in the hearing, within the Education and Human Resources Directorate, there is a Human Resource Development Division that up until the FY 12 budget request was intended to "play a central role in increasing opportunities in STEM education for individuals from historically underserved populations—minorities, women, and persons with disabilities." The FY 12 budget request realigns the Division, reducing funding for and shifting several programs to another Division. Of the $160 million budget request for the Division ($20 million of which is for a new broadening participation program), only $1.6 million is available for "increasing opportunities in STEM education" for women and zero is available for "increasing opportunities in STEM education" for persons with disabilities. Can you please explain the rationale for this and why this Division has become more narrowly focused?

A15. The Division of Human Resource Development (HRD) within EHR is described in the following link: http://www.nsf.gov/ehr/hrd/abouUsp, HRD serves as a focal point for NSF's agency-wide commitment to enhancing the quality and excellence of science, technology, engineering, and mathematics (STEM) education and research through broadening participation by underrepresented groups and institutions, The Division's programs aim to increase the participation and advancement of underrepresented minorities and minority-serving institutions, women and girls, and persons with disabilities at every level of the science and engineering enterprise, Programs within HRD have a strong focus on partnerships and collaborations in order to maximize the preparation of a well-trained scientific and instructional workforce for the new millennium.

There has been no change in the division's commitment to broadening participation for all groups traditionally underrepresented in STEM. All HRO programs, including the Louis Stokes for Minority Participation (LSAMP), the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), and the Tribal Colleges and Universities Program (TCUP) share the commitment to broadening participation for all, including women and persons with disabilities, In fact, a number of projects funded in these and other HRD programs have specific focus on issues facing women and persons with disabilities, The proposed administrative shift for the Research in Disabilities Education (ROE) and the Research on Gender in Science and Engineering (GSE) programs is to improve program management, leverage resources, and build coherence across all of EHR in the research domain, The two expert scientific staff who manage these programs will remain members of the HRD staff, and will continue to play key roles in ensuring that a full-scale view of broadening participation for all groups is central in all HRO investment areas and across EHR.

Broadening Participation

Q16. Also, per our hearing exchange, including the Human Resource Development Division programs, would you please provide us with funding and programmatic details on all programs within the Foundation that are either specific to serving "historically underserved populations—minorities, women, and persons with disabilities" or provide special considerations for these populations?

A16. NSF has taken a variety of approaches to broaden participation across its many programs. While broadening participation is included in the NSF review criteria, some program announcements and solicitations go beyond the standard criteria. They range from encouraging language to specific requirements. The following table represents the set of programs that have been historically tracked as Broadening Participation for budget purposes. These programs support broadening participation activities that serve historically underrepresented populations minorities, women, and persons with disabilities.

For a complete listing of NSF's Broadening Participation portfolio please see the website http://www. nsf.gov/od/broadeninaparticipation/bp—portfolio—dynamic.jsp.

NSF Programs to Broaden Participation
FY 2012 Request to Congress

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[4]	FY 2012 Request
EHR/HRD	ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE)	The goal of the ADVANCE program is to develop systemic approaches to increase the representation and advancement of women in academic science, technology, engineering and mathematics (STEM) careers, thereby contributing to the development of a more diverse science and engineering workforce. ADVANCE focuses on ensuring that women faculty with earned STEM degrees consider academia as a viable and attractive career option.	$21.01	-	$21.02	$21.65
EHR/DUE	Advanced Technological Education (ATE)	With an emphasis on two-year colleges, the ATE program focuses on the education of technicians for the high-technology fields that drive our nation's economy. The program involves partnerships between academic institutions and employers to promote improvement in the education of science and engineering technicians at the undergraduate and secondary levels.	64.51	-	64.00	64.00
EHR/HRD	Alliances for Graduate Education and the Professoriate (AGEP)	The AGEP program enables seamless transitions from the STEM baccalaureate to attainment of the doctorate and entry to the STEM professoriate. Its main goal is to increase the number of students successfully completing quality degree programs in science, technology, engineering and mathematics (STEM) with particular emphasis placed on transforming STEM education through innovative academic strategies and experiences in support of groups that historically have been underrepresented in STEM disciplines: African-Americans, Alaskan Natives, Native Americans, Hispanic Americans, and Native Pacific Islanders. AGEP furthers the graduate education of underrepresented STEM students through the doctorate level, preparing them for fulfilling opportunities and productive careers as STEM faculty and research professionals. AGEP also supports the transformation of institutional culture to attract and retain STEM doctoral students into the professoriate.	16.73	-	16.75	16.75
CISE	Broadening Participation in Computing (BPC)	The BPC program aims to significantly increase the number of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines. Initially, its emphasis will be on students from communities with longstanding underrepresentation in computing: women, persons with disabilities, and minorities. Included minority groups are African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, and Pacific Islanders. While these efforts focus on underrepresented groups, it is expected that the resulting types of interventions will improve research and education opportunities for all students in computing.	14.00	-	14.00	-
EHR/HRD	Centers of Research Excellence in Science and Technology (CREST)	The Centers of Research Excellence in Science and Technology (CREST) program makes resources available to enhance the research capabilities of minority-serving institutions through the establishment of centers that effectively integrate education and research. CREST promotes the development of new knowledge, enhancements of the research productivity of individual faculty, and an expanded presence of students historically underrepresented in STEM disciplines.	30.32	-	30.53	30.53
EHR/HRD	Transforming Broadening Participation through STEM (TBPS)	Transforming Broadening Participation through STEM (TBPS) is new program that will seek innovative solutions for broadening participation in STEM at the undergraduate level in anticipation of tomorrow's changing demographics, including increased engagement with Hispanic-serving institutions.	-	-	-	20.00

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
OCI	Cyberinfrastructure Training, Education, Advancement and Mentoring (CI-TEAM)	The CI-TEAM program supports Demonstration and Implementation Projects aimed at positioning the national science and engineering community to more effectively engage in national and global research and education activities that promote and leverage cyberinfrastructure. CI-TEAM awards will: • Prepare current and future generations of scientists, engineers, and educators to use, support, deploy, develop, and design cyberinfrastructure; and • Foster inclusion in cyberinfrastructure activities, of diverse groups of people and organizations, with particular emphasis on traditionally underrepresented groups.	4.85	-	5.00	4.00
IA	Experimental Program to Stimulate Competitive Research (EPSCoR)	The Experimental Program to Stimulate Competitive Research (EPSCoR) is a program designed to fulfill the National Science Foundation's (NSF) mandate to promote scientific progress nationwide. The EPSCoR program is directed at those jurisdictions that have historically received lesser amounts of NSF Research and Development (R&D) funding. Twenty-seven states, the Commonwealth of Puerto Rico and the U. S. Virgin Islands are currently eligible to participate. Through this program, NSF establishes partnerships with government, higher education and industry that are designed to effect lasting improvements in a state's or region's research infrastructure, R&D capacity and hence, its national R&D competitiveness.	147.11	20.00	147.12	160.53
GEO	GEO LSAMP Linkages	The LSAMP-Linkages account provides co-funding for projects submitted to the GEO Education and Diversity programs that help to infuse geoscience content areas into existing LSAMP programs that have limited geoscience focus.	1.00	-	1.00	1.00
ENG	Graduate Research Diversity Supplements (GRS)	Graduate Research Diversity Supplements is an opportunity to broaden participation particularly of underrepresented students in Ph.D. programs in engineering through supplements to current research grants funded by the divisions in the Directorate for Engineering (ENG) at the National Science Foundation. The establishment of Graduate Research Supplements (GRS) reflects the continuing effort by ENG to promote increased participation of new Ph.D. students in all fields of engineering research with particular emphasis on individuals from underrepresented groups. The long-term goal of GRS is to increase the number of persons from underrepresented groups in advanced academic and professional careers.	2.06	-	1.50	1.50
ENG/CISE	Graduate Research Fellowship - Women in Engineering and Computer Science	The Graduate Research Fellowship Program awards fellowships for graduate study leading to research-based master's or doctoral degrees in the fields of science, technology, engineering, and mathematics (STEM) relevant to the mission of the National Science Foundation. The Women in Engineering and Computer and Information Science awards are for women who intend to pursue graduate research degrees in Engineering or Computer and Information Science and Engineering. Additional funding for these awards is provided by the Directorate for Computer and Information Science and the Directorate for Engineering. Eligibility, application, and review criteria are the same as for applicants in other fields.	9.88	-	9.55	-
EHR/DRL	Innovative Technology Experiences for Students and Teachers (ITEST)	The ITEST program invests in K-12 activities that addresss shortages of STEM professionals and information and communications technology workers in the U.S. and K-12 activities that seek to expand the beadth and depth of the STEM workforce, through programs for students and teachers and educational research. The ITEST program advances the EHR themes of broadening participation to improve workforce development, promoting cyber-enabled learning starategies, and advancing STEM literacy. ITEST is supported by H-1B VISA fees.				

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
EHR/DUE	Scholarships in Science, Technology, Engineering and Mathematics (S-STEM)	The S-STEM program makes grants to institutions of higher education to support scholarships for academically talented, financially needy students, enabling them to enter the workforce following completion of an associate, baccalaureate, or graduate level degree in science and engineering disciplines. The program was established by the National Science Foundation (NSF) in accordance with the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) as modified by P.L. 106-313 and P.L.108-447 in 2004. The predecessor program to S-STEM is the NSF Computer Science, Engineering, and Mathematics Scholarships (CSEMS) program. The major change from CSEMS is that S-STEM increased the number of disciplines that could participate in the program.	96.91	-	100.00	100.00
EHR/HRD	Historically-Black Colleges and Universities-Undergraduate Program (HBCU-UP)	The Historically Black Colleges and Universities-Undergraduate Program (HBCU-UP) supports awards that enhance the quality of undergraduate STEM programs through curricular reform and enhancement, faculty development, research experiences for undergraduates, upgrading of scientific instrumentation, and improvement of research infrastructure.	32.06	-	32.00	32.00
EHR/DRL	Informal Science Education (ISE)	Informal Science Education (ISE) will continue to emphasize projects that advance informal STEM education nationally and build on lessons learned from education research. Priority is placed on projects that strengthen infrastructure; engage underserved audiences, including young children and older adults; incorporate inquiry in after-school programs; involve the public in the scientific process; and apply new technologies to informal learning.	65.85	-	66.00	68.14
EHR/MPS/ BIO	Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)	The UBM program aims to enhance undergraduate education and training at the intersection of the biological and mathematical sciences and to better prepare undergraduate biology or mathematics students to pursue graduate study and careers in fields that integrate the mathematical and biological sciences.	2.70	-	2.70	-
EHR/HRD	Louis Stokes Alliances for Minority Participation (LSAMP)	Louis Stokes Alliances for Minority Participation (LSAMP) strengthen and encourage STEM baccalaureate degree production of students from underrepresented populations by utilizing the knowledge, resources, and capabilities of a broad range of organizations.	44.55	-	44.75	44.75
EHR/DUE	Math and Science Partnership (MSP)	The Math and Science Partnership (MSP) program is a major research and development effort that supports innovative partnerships to improve K-12 student achievement in mathematics and science. In particular, MSP projects seek to integrate the work of higher education, especially its science, technology, engineering and mathematics (STEM) disciplinary faculty, with that of K-12 to strengthen and reform mathematics and science education. MSP projects are expected to raise the achievement levels of all students and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations. In order to improve the mathematics and science achievement of the Nation's students, MSP projects contribute to the knowledge base for mathematics and science education and serve as models that have a sufficiently strong evidence base to be replicated in educational practice.	57.93	-	58.22	48.22
BIO	BIO Minority Post-Doctoral Research Fellowships	The Directorate for Biological Sciences (BIO) awards postdoctoral research fellowships to recent recipients of the doctoral degree for research and training in selected areas supported by BIO. The BIO Minority Postdoctoral Research Fellowships have been offered since FY 1990 in order to increase the participation of under-represented groups in biology. The program supports a wide range of biological research and training across the full range of BIO's research programs.	2.82	-	2.50	2.50

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
SBE	SBE Minority Post-Doctoctoral Research Fellowships	The Directorate for Social, Behavioral and Economic Sciences (SBE) offers Minority Postdoctoral Research Fellowships and Research Starter Grants in an effort to increase the diversity of researchers who participate in NSF programs in the social, behavioral and economic sciences and thereby increase the participation of scientists from underrepresented groups in selected areas of science in the United States. These activities (postdoctoral fellowships and follow-up research starter grants) support training and research in the areas of social, behavioral and economic sciences within the purview of NSF.	0.94	-	1.00	1.00
EHR/DUE	Noyce Scholarships	The Robert Noyce Teacher Scholarship Program seeks to encourage talented science, technology, engineering, and mathematics majors and professionals to become K-12 mathematics and science teachers. The program provides funds to institutions of higher education to support scholarships, stipends, and academic programs for undergraduate STEM majors and post-baccalaureate students holding STEM degrees who commit to teaching in high-need K-12 school districts. A new component of the program supports STEM professionals who enroll as NSF Teaching Fellows in master's degree programs leading to teacher certification by providing academic courses, professional development, and salary supplements while they are fulfilling a four-year teaching commitment in a high need school district. This new component also supports the development of NSF Master Teaching Fellows by providing professional development and salary supplements for exemplary math and science teachers to become Master Teachers in high need school districts.	54.93	-	55.00	45.00
GEO	Ocean Sciences Postdoctoral Fellowship[2]	The Division of Ocean Sciences (OCE) awards Postdoctoral Fellowships to highly qualified investigators within 3 years of obtaining their PhD to carry out an integrated program of independent research and education. The research and education plans of each fellowship must address scientific questions within the scope of OCE disciplines. The program supports researchers for a period of up to 2 years with fellowships that can be taken to the institution or national facility of their choice.	-	-	-	1.90
GEO	Opportunities to Enhance Diversity in the Geosciences (OEDG)	The OEDG program provides targeted education, research, and mentoring activities that will increase the number of members of underrepresented groups involved in formal pre-college and informal geoscience education programs, pursuing undergraduate and advanced degrees in the geosciences, and entering geoscience careers.	4.18	-	4.60	3.60
IA	Partnerships for Innovation (PFI)	The Partnerships for Innovation (PFI) program is intended to forge connections between new knowledge created in the discovery process and learning and innovation. The PFI program defines innovation as the transformation of knowledge into products, processes, systems, and services that are novel and of economic value to society. One of the general goals of the Partnerships for Innovation Program (PFI) is to stimulate the transformation of knowledge created by the research and education enterprise into innovations that create new wealth; build strong local, regional, and national economies; and improve the national well-being.	9.25	-	9.19	28.69
MPS	Partnerships in AST & Astrophysics Rsch Educ (PAARE)[3]	The objective of Partnerships in Astronomy & Astrophysics Research and Education (PAARE) is to enhance diversity in astronomy and astrophysics research and education by stimulating the development of formal, long-term, collaborative research and education partnerships among minority-serving institutions and partners at research institutions, including academic institutions, private observatories and NSF Division of Astronomical Sciences (AST) supported facilities.	0.74	-	2.00	-

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
MPS	Partnerships for Research and Education in Materials (PREM)	The objective of PREM is to enhance diversity in materials research and education by stimulating the development of formal, long-term, collaborative materials research and education partnerships between minority-serving institutions and the National Science Foundation (NSF) Division of Materials Research (DMR) supported groups, centers, and facilities.	5.52	-	5.53	6.00
ENG	Pre-Engineering Education Collaboratives (PEEC)[4]	Pre-Engineering Education Collaboratives (PEEC) provides support for pilot efforts to establish or enhance engineering pipelines in TCUP institutions, alone or in collaboration with other TCUP institutions and colleges of engineering.	1.00	-	1.00	1.00
EHR/HRD	Research in Disabilities Education (RDE)[5]	The RDE program seeks to broaden the participation and achievement of people with disabilities in all fields of STEM education and associated professional careers. The RDE program places particular emphasis on contributing to the knowledge base by addressing disability related differences in secondary and post-secondary STEM learning and in the educational, social and pre-professional experiences that influence student interest, academic performance, retention in STEM degree programs, STEM degree completion, and career choices. Projects also investigate effective practices for transitioning students with disabilities across critical academic junctures, retaining students in undergraduate and graduate STEM degree programs, and graduating students with STEM associate, baccalaureate and graduate degrees. Research project results inform the delivery of innovative, transformative and successful practices employed by the Alliances for Students with Disabilities in STEM to increase the number of students with disabilities completing associate, undergraduate and graduate degrees in STEM and to increase the number of students with disabilities entering our nation's science and engineering workforce.	6.92	-	6.50	6.50
BIO	Research Initiation Grants in Biology (RIG)	Research Initiation Grants in Biology (RIG) is intended to broadening participation to all biologists including members from groups under-represented in biology. These grants are intended to increase the diversity of researchers who apply for and receive BIO funding to initiate research programs early in their careers. Currently, African Americans, Hispanics, Native Americans, Alaska Natives, and Native Hawaiians and other Pacific Islanders are under-represented in biology.	1.91	-	2.00	-
EHR/HRD	Research on Gender in Science and Engineering (GSE)[5]	The Research on Gender in Science and Engineering (GSE) program supports efforts to understand and address gender-based differences in STEM education and workforce participation through research, the diffusion of research-based innovations, and extension services in education that will lead to a larger and more diverse domestic science and engineering workforce. The focus of the GSE program is on building resources--developing the nation's knowledge capital, social capital, and human capital--toward the goal of broadening the participation of girls and young women in STEM education from kindergarten through undergraduate education. The program targets the creation of new knowledge and the dissemination of that knowledge to practitioner communities. The program does not currently fund direct intervention or education projects that directly serve students as their primary purpose. In 2003 the program changed focus from direct implementation projects for women and girls (e.g., summer camps, women in science programs on campuses, etc.) to research and the targeting of practitioners with pedagogical, recruitment, retention and other strategies with some evidence of success.	11.57	-	11.50	10.50
EHR/DUE	Science, Technology, Engineering and Math Talent Expansion Program (STEP)	The Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) seeks to increase the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields within STEM. Type 1 proposals are solicited that provide for full implementation efforts at academic institutions. Type 2 proposals are solicited that support educational research projects on associate or baccalaureate degree attainment in STEM.	31.64	-	32.53	35.53

(Dollars in Millions)

Directorate/ Office	Program Name	Program Description	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR[1]	FY 2012 Request
GEO	Significant Opportunities in Atmospheric Research and Science (SOARS)	SOARS seeks to broadening participation in the atmospheric and related sciences. It is an undergraduate to graduate program built around a summer research internship, mentoring by top scientists, and a supportive learning community.	0.67	-	0.60	0.60
EHR/HRD	Tribal Colleges and Universities Program (TCUP)	Tribal Colleges and Universities Program (TCUP) promotes the improvement of STEM instructional and community outreach programs, with an emphasis on the leveraged use of information technologies at Tribal Colleges and Universities, Alaska Native-serving institutions and Native Hawaiian-serving institutions. This program provides awards to enhance the quality of STEM instructional and outreach programs at Tribal Colleges and Universities, Alaska Native-serving and Native Hawaiian-serving institutions of higher education. Support is available for the implementation of comprehensive institutional approaches to strengthen STEM teaching and learning in ways that improve access to, retention within, and graduation from STEM programs. Through this program, assistance is provided to eligible institutions in their efforts to prepare students for careers in science, mathematics, engineering, and technological fields. Proposed activities should be the result of a careful analysis of institutional needs, address institutional and NSF goals, and have the potential to result in significant and sustainable improvements in STEM program offerings.	13.35	-	13.35	14.35
MPS	Undergraduate Research Collaboratives (URC)	The URC program develops new models and partnerships between research universities, 4-year colleges and 2-year colleges with the potential to expand the reach of undergraduate research to include first- and second-year college students, to broaden participation, and increase diversity in the student talent pool from which the nations's future technical workforce will be drawn and to enhance the research capacity, infrastructure and culture of participating institutions.	1.00	-	1.00	-
BIO	Undergraduate Research Mentoring in Biology (URM)	URM funds projects that have strong research and mentoring activities designed to prepare students for successful entry into graduate programs. URM will support projects involving the recruitment, retention and development of undergraduate students, especially those from underrepresented groups, for the purpose of preparing them for graduate study in the biological sciences. Proposed projects are expected to create a URM program that will actively engage students in interesting and exciting research ideas, provide hands-on research experience, and develop their academic skills.	9.00	-	3.00	-
	TOTAL, NSF		**$766.80**	**$20.00**	**$765.44**	**$770.24**

[1] A full-year 2011 appropriation for these programs was not enacted at the time the budget was prepared; therefore, these programs are operating under a continuing resolution (P.L. 111-242, as amended). The amounts included for 2011 reflect the annualized levels provided by the continuing resolution.

[2] The Ocean Sciences Postdoctoral Fellowship is a new program beginning in FY 2012.

[3] Partnerships in Astronomy and Astrophysics Research Education (PAARE) replaces Research Partnerships for Diversity (RPD).

[4] Pre-Engineering Education Collaboratives (PEEC) replaces Tribal College Pathways in ENG.

[5] Funding for Research in Disabilities Education (RDE) and Research on Gender in Science and Engineering (GSE) for FY 2012 is proposed to reside in the Research & Evaluation on Education in S&E (REESE) program in EHR.

Questions submitted by Representative Randy Hultgren

DUSEL

Q17. *During this time in which the energy frontier and some of our brightest minds have been shifting to Europe for the development, operation, and promise of science from the Large Hadron Collider, the U.S. must not cede our leadership in a future discovery frontier. A robust national program in elementary particle physics is a central component of both the NSF and DOE contributions to fundamental physics research and it is required for the U.S. to remain competitive on the international scale. Over the last decade, a series of reports outlined compelling questions in modern science that can be answered only in a deep underground environment. In response to this, the science community has overwhelmingly supported the construction and operation of a national underground laboratory. Research communities in physics, geosciences, engineering, biology, and other fields have further refined the questions and defined the critical experiments that would require access to scientific facilities deep underground. As planning continues for this project, early and formal continued participation by the NSF is critical.Recognizing the importance of this facility, the commitment of Fermilab in my district of Illinois, and the overwhelming support of the scientific community, how does the National Science Foundation, which supports research across science and engineering fields, intend to continue to be formally involved in the development of the Deep Underground Science and Engineering Laboratory (DUSEL) along with the Department of Energy?*

A17. NSF will continue to consider grant proposals for future particle physics research and other fields, including underground experiments that might be conducted at Homestake, should DOE decide to support the core infrastructure there, or at other existing sites in the United States and around the world.

Q18. In addition, in this time of budgetary constraints, it is more important than ever for the U.S. and NSF to be leveraging financial commitments made by other partners and demonstrating a sustainable development process to keep facilities costs down. Increasingly, the construction of these large facilities not only requires non-federal contributions but multi-agency collaboration within the federal government.I was discouraged to see that the NSF has proposed zero funding for DUSEL in FY 2012 after more than $250 million invested to date from federal, state, and private sources and hundreds of jobs already created.In the America COMPETES Act enacted in 2010, Congress recognized the need for NSF "in its planning for construction and stewardship of large facilities, to coordinate and collaborate with other Federal agencies, including the Department of Energy's Office of Science, to ensure that joint investments may be made when practicable." What is the current status of negotiations and participation of NSF with the DOE in the 'future of the Long-Baseline Neutrino Experiment (LBNE) and the development of an underground laboratory?

A18. DOE has initiated a scientific assessment to determine the optimal location for the Long Baseline Neutrino Experiment (LBNE) far detector and the full suite of experiments in which their programs are highly engaged, namely dark matter and double beta-decay. This assessment, which will include Homestake and other possible sites, is expected to conclude in time to inform preparation of DOE's FY 2013 budget request.

Pending a DOE decision on the location of the LBNE far detector, NSF and DOE are working together to preserve the viability of the Homestake site in FY 2011. NSF has agreed to provide $4.0 million during the remainder of FY 2011 to sustain pumping operations at the Homestake site. DOE has included $15.0 million in its FY 2012 budget request, presently before Congress, to extend pumping operations through FY 2012.

Q19. Will NSF complete its funding of the 15 awards it has made to date to study initial experiments for early science which could be conducted in such a unique underground laboratory environment?

A19. Yes. The final allotment (third year) of funding for the Directorate for Mathematical and Physical Sciences, Physics Division (MPS/PHY) component of the DUSEL Solicitation 4 (S4) awards are included in the FY 2011 Budget Request. These nine continuing awards in MPS/PHY will be made and the S4 commitments completed. The Directorate for Geosciences intends to fund the final year of the seven DUSEL S4 awards that were co-funded with the Directorate for Engineering and Directorate for Biological Sciences.

Q20. The implications of the future research at DUSEL go far beyond the science discoveries themselves, as opportunities to attract students at all ages have been built into the plan, with the potential to redirect future scientists to the U.S. rather than our foreign competitors. Most importantly, the impact this facility will have can be seen from the impact it is already having. Summer scholarships, intern programs for students in science to conduct research at DOE's Fermi National Accelerator Laboratory in Batavia, Illinois, and a new Master's degree and doctoral degree program in physics within the South Dakota university system have all been developed as a result of the future DUSEL facility. Is NSF working with the relevant partners to identify ways to ensure that these activities and our nation's commitment to science education continue while the federal agencies are working on the appropriate stewardship model?

A20. NSF continues to be committed to workforce development in all fields of science and engineering.

Q21. How is NSF prepared to work with the university community to ensure that the research needs will still be met with any proposed changes to the existing plans for DUSEL?

A21. The NSF Directorate for Mathematical and Physical Sciences, Physics Division (MPS/PHY) is prepared to work with the nuclear and particle physics university communities to pursue underground research through the normal grant and proposal peer-review process.

Questions submitted by Representative Daniel Lipinski

Research Infrastructure

Q22. I'm greatly concerned that we are under-investing in research and teaching laboratories, instrumentation, and shared-use facilities. I am worried that not only will this make it difficult to compete for top talent with countries like China, but that it will lead to the inefficient use of limited research dollars. As a former Dean of Engineering, what is your impression of the state of our nation's academic research infrastructure? Is it limiting researchers or causing problems recruiting or retaining top talent? I realize this might not be such an issue at MIT, but I would like to know your perspective on the country as a whole.

A22. NSF"s National Center for Science and Engineering Statistics (NCSES) collects data from academic institutions about the state of their science and engineering (S&E) research facilities space, Nationally representative data are not available specific to instrumentation, and shared-use facilities, There are no comparable international data on research infrastructure,

In FY 2007, the most recent year for which data are available, there were 188 million net assignable square feet (NASF) of S&E research space at academic institutions. Institutions rated 17 percent of that space as requiring renovation and five percent of that space as requiring replacement The condition of the space varies by S&E field (see Table 5).

The federal government is a relatively small source of the total funding used by academic institutions for repair and renovation or new construction of S&E research space. Academic institutions reported that the completion costs for repair, renovation, and new construction of S&E research facilities begun during FY 2006 and FY 2007 were $3.362 billion and $5.924 billion, respectively. The federal government was the source of $134 million (4 percent) and $361 million (6 percent) of those funds, respectively.

Since the mid-1990s, the federal government's share of funding for repair and renovation of academic S&E research space has fluctuated between four percent and ten percent, and the share of funding for new construction of academic S&E research space has fluctuated between four percent and nine percent

In FY 2007, the estimated costs of deferred projects included in academic institutional plans to repair or renovate S&E research space was $5.154 billion; estimated costs of deferred projects included in academic institutional plans to construct new S&E research space was $10.423 billion. Consequently, in FY 2007 total estimated costs of deferred projects were $15.577 billion. In FY 2005, total estimated costs of deferred projects were $13.786 billion, In FY 2003, total estimated costs of deferred projects were $12.781 billion.

Research infrastructure is essential to scientific discovery and a strong U.S. scientific and engineering enterprise. In today's environment, shared-use facilities

which are accessed by the broader U.S. scientific and engineering research community are encouraged and supported by NSF. While access to high-quality, research infrastructure is one factor that influences individual researchers' employment decisions, and space and equipment packages routinely are part of new recruitment and retention negotiations, data on the impact of the current status of S&E research space on recruiting and retention are scarce. A variety of other factors are as likely to influence recruitment and retention decisions including—salary/compensation, career advancement, access to research funding, the opportunity to work with the best in a given field, and family considerations. The extent to which the adequacy of research infrastructure is the determining factor is not known and may be discipline dependent with some disciplines having greater research infrastructure requirements than others.

Data Notes:

- Data are reported for academic institutions with $1.0 million or more in research and development (R&D) expenditures (from all sources). The data are collected on the NCSES Survey of Science and Engineering Research Facilities.
- Research space is space where research activities occur. For example, it includes laboratories used for research, shared-use facilities, and space used to house fixed equipment or equipment costing $1.0 million or more that is used for research. It does not include teaching laboratory space.
- Deferred projects are those that are (1) not funded and (2) not yet scheduled to start in the next two years. They do not include projects planned for developing new programs or expanding current programs.
- Institutional plans usually will include goals, strategies, and budgets for fulfilling the institution's mission during a specific time period.
- According to the survey definitions, space requiring renovation "will no longer be suitable for current research without undergoing major renovation within the next two years." Space requiring replacement is defined as "should stop using space for current research within the next 2 years."
- According to the survey definitions, space in superior condition is "suitable for the most scientifically competitive research over the next two years." Space in satisfactory condition is "suitable for continued use over the next two years for most levels of research . . . but may require minor repairs or renovation."

Q23. In the Recovery Act, we spent about $200 million on infrastructure through the NSF's ARI-R2 program. Based on that program, do you have any insights into how much need there is out there, and whether this kind of investment can help address it?

A23. The FY 2007 Survey of Science and Engineering Research Facilities, the most recent year for which data are available, estimated that academic institutions had at least $5.15 billion in deferred projects to repair and renovate science and engineering research space and at least $10.42 billion in deferred projects to construct new science and engineering research space. Proposals totaling $1.02 billion were submitted to the ARI-R2 program. Indirect cost recoveries through federal grants may also be used by universities to offset costs incurred for maintenance, repair, and upkeep of buildings or equipment. Funding for academic research infrastructure also comes from other federal agencies, industry, state governments, and private endowments. In short, academic infrastructure needs are large and are best addressed through these multiple funding streams.

Questions submitted by Representative Ben Ray Lujan

Broadening Participation

Q24. Dr. Suresh, thank you for your commitment to increasing minority and women participation in STEM fields of study. Thank you also for your request of $14.35 million for the Tribal Colleges and Universities Program that will enhance STEM programs in tribal colleges across the country. The America COMPETES Reauthorization Act requires NSF to support the Historically Black Colleges and Universities Undergraduate Program, the Tribal Colleges and Universities Program and Hispanic Serving Institutions programs as separate programs. The FY 2012 budget request funds HBCU-UP and TCUP separately; however, the budget request does not include a "Hispanic Serving Institutions Program." As you noted in your written testimony, the National Science Foundation requested $20 million for a new program called Transforming

Broadening Participation through STEM (TBPS). While it is clear that this program will be available to HSIs, it seems that it might be available to other Minority Serving Institutions as well. Can you provide clarification on TBPS, and the NSF's plans to comply with the requirement in COMPETES that HSIs are supported as a separate program?

A24. In FY 2008 and 2009, NSF initiated a series of listening sessions with the Hispanic-serving institution (HSI) community to understand the diverse needs and opportunities for broadening participation of Hispanic students in STEM fields. From those sessions, NSF learned that many of the challenges facing HSIs in increasing participation are the same challenges faced by other minority-serving institutions, and that many of the strategies that have been most promising in engaging Hispanic students in STEM show promise for engaging all students. NSF continues to analyze, engage, and inform the higher education communities' direction and approach to workforce development and broadening participation in science, technology, engineering, and mathematics (STEM). NSF's ongoing study includes a thorough analysis of underrepresented group STEM enrollment and graduation over time in institutions of higher education in the United States.

As a result of this work. NSF will develop strategies for strengthening STEM education at the undergraduate level in colleges and universities throughout the Nation. Data about the particular needs and contexts in the wide range of HSIs across the Nation will be essential in this future planning. NSF will also address these opportunities through the proposed new Transforming Broadening Participation through STEM (TBPS) program included in the FY 2012 Budget Request. This new program will seek innovative solutions for broadening participation in STEM at the undergraduate level in anticipation of tomorrow's changing demographics including increased engagement with HSIs.

NSF continues to engage in planning across agencies. including with the White House Initiative on Educational Excellence for Hispanics. to ensure that the multiple programmatic offerings across government that serve Hispanic-serving institutions are well coordinated, and that the NSF contribution is aligned with the unique role that the agency can best play.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Ray Bowen, Chairman of the National Science Board

Question Submitted by Chairman Ralph Hall

Q1. As you are well aware, the recently passed House Continuing Resolution reduces funding for the MREFC account significantly. Should that amount become law, please describe how NSF will distribute the funding across current projects.

A1. The NSB invests substantial efforts to oversee the Foundation's MREFC process. Projects are repeatedly assessed throughout the planning, construction, and operations stages. The Board embraces NSF's "no cost overrun" policy, which requires that the project cost estimate include adequate contingency funds to cover all foreseeable risks, and that any cost increases not covered by contingency, be accommodated by scope reduction.

The Board's Subcommittee on Facilities (SCF) is continually assessing and prioritizing the research infrastructure supported by the Foundation. Should the MREFC account face a dramatic reduction in funding, NSB through the SCF, the Committee on Program and Plans, and the Committee on Strategy and Budget, will work closely with NSF to reassess the MREFC priorities. This process is ongoing.

Questions Submitted by Representative Mo Brooks

Q2. What role did the National Science Board play in establishing the priorities for the Foundation in the FY 12 Budget Request? How does the Board prioritize its funding decisions for the Foundation and what criteria does it use in making these recommendations?

A2. The Board participates in the development of the agency's budget priorities primarily through its Committee on Strategy and Budget, which engages with NSF senior leadership from the initial planning stage for the next budget through informal discussions, numerous teleconferences, formal presentations, and final approval of the submission to OMB. The prioritization process is very iterative; there is no set formula. Considerations include the potential for impact, the readiness of the community, and the ability of programs to leverage activities with other resources.

In working with the agency on determining priorities, the Board takes into account concerns of the Administration, Congress, and the Nation's science and engineering community as a whole. In the end, the Board believes that this continual assessment and reassessment of research priorities brings the best budget forward for the Foundation and for the Nation.

Q3. The Administration's Innovation Strategy details its efforts to strengthen our nation's competitiveness and long-run economic growth. What role does the Board play in measuring and evaluating the economic impacts of basic research funding? What methods does the Federal Government use to prioritize funding areas of basic research, both within an area of science and across areas of science?

A3. The Board has statutory responsibility for generating the biennial Science and Economic Indicators (SEI) report which provides quantitative data trends of research areas. The report also provides the quantitative data to assess the status of U.S. science and engineering relative to other nations. The data from SEI is an important resource for federal science and engineering policymakers, including the Board, for use in determining funding priorities.

Q4. The NSF FY 12 Budget eliminates and reduces several programs across the Directorates, but does not go nearly far enough in my opinion. At the same time, several new programs are being created and many directed programs are receiving increases. I am concerned that while programs like the Graduate STEM Fellows in K-12 Education and the National STEM Distributed Learning Program are on your list because evaluations have shown that they are not necessarily proven programs, it seems that NSF is simply looking to shift those dollars (and more) into new, unproven programs. Can you explain the decision-making process for the terminations and reductions as well as the creation of the new programs? Is the scientific community driving these decisions or is the Administration?

A4. NSB regularly receives updates from the Foundation on the development of new programs. For education programs, NSB's Committee on Education and Human Resources works closely with NSF's Education directorate to ensure decisions are based on the latest research in learning and consistent with national recommenda-

tions on STEM education. When determining priorities for the Foundation, the Board takes into account a wide range of evaluations, ranging from concerns of the Administration and Congress to the Nation's science and engineering community as a whole. In the end, the Board believes that this continual assessment and reassessment of priorities brings the best budget forward for the Foundation and for the Nation.

Q5. The word "new" appeared 34 times in Dr. Suresh's testimony and 17 times in yours. Most of these references were to new programs or initiatives. In light of our current economic reality when the American people are begging us to change our spending habits and resources are precious, why is it necessary to begin new programs? Can you provide a better justification for the creation of these new programs mentioned in your testimony, especially those that seem to duplicate existing programs, such as Teacher Learning for the Future, and Transforming Broadening Participation through STEM?

A5. NSB strongly believes that to maintain our Nation's competitive edge, research must be nimble in its funding priorities as we continuously evaluate the nation's research portfolio. NSF and the Board continually evaluate and assess the agency's portfolio with input from the research community, Congress, and the Administration, to ensure that the taxpayers' investment yields maximal returns. This evaluation fosters innovation in both well-established and novel areas. The Board recognizes there are risks whenever a new program is created or a well-established program is terminated. It is for this reason that the agency engages in extensive deliberation-both internally and in consultation with the external research community, the Administration, and other Federal agencies-to ensure that any changes to NSF's portfolio are based on the best possible information.

Q6. I understand and respect that, as you mentioned in hearing testimony, "neglecting scientific research and education now will have serious consequences for the future of our country." However, Congress is faced with many difficult funding decisions in our current economic situation. Every Committee is hearing similar pleas from education to transportation and from energy to defense. Federal funding cuts are a likely reality over the next few years. How would you suggest we look at reigning in government expenditures across the board? How do we prioritize programmatic funding for the Foundation?

A6. With its oversight responsibilities for the Foundation, the Board engages thoroughly with NSF management on determining the agency's funding priorities. The budget request for Fiscal Year 2012 reflects this collaboration. The investments outlined in NSF's Budget Request support the areas of science and engineering research and education that NSF, with NSB support, has identified as the Foundation's priorities.

The Board believes it is critical to examine programs under the lens of long-term success and benefits to our country and its citizens. Though it might be tempting to forego long-term investments in the face of current economic challenges, neglecting scientific research, engineering and education now, we believe, will have long-term negative consequences on our country's future. As noted in the Board's report "Globalization of Science and Engineering Research: A Companion to Science and Engineering Indicators 2010," other countries now actively seek to emulate our success by building their own innovation infrastructures, we must be ever vigilant to enhance our own innovative capacity.

Q7. Scattered throughout the entire federal budget request are dramatic increases in spending on "clean technologies." At the Department of Energy alone, there are enormous spending increases for clean tech through ARPA-E, EERE, the Office of Science, the Loan Guarantee Program, and Energy Innovation Hubs, to name just a few. Similar programs are proposed throughout the government, including NSF's "Science, Engineering, and Education for Sustainability (SEES)" portfolio intended to "spark innovations for tomorrow's clean energy sources with a cross-disciplinary approach to sustainability science." The FY 12 budget request is $998 million for this effort. This is a 51 percent increase over the FY I 0 amount and reflects 13 percent of the entire NSF budget. What role did the National Science Board play in determining these specific priorities for the Foundation?

A7. The Board participates in the development of the budget primarily through its Committee on Strategy and Budget, which engages with NSF senior leadership from the initial planning stage for the next budget through informal discussions, numerous teleconferences, and final approval of the submission to OMB. In working with the agency on determining priorities, the Board takes into account the priorities of the Administration and Congress. The Board also brings, through its members who

are selected to represent the leadership of U.S. science and engineering, expertise concerning the needs and strengths of the Nation's science and engineering community as a whole.

Q8. You identify NSF as the "only federal agency dedicated to the support of basic research and education in all fields of science and engineering." Are the more applied areas of research identified in the America COMPETES Reauthorization Act, coupled with many Administration applied priorities for NSF in the FY 12 budget request diluting the funding for basic, fundamental research?

A8. NSB recognizes basic research as the underpinning of the scientific enterprise. But its benefits will be achieved only in connection with other parts of the nation's scientific and technological enterprise, including applied research, education, technology transfer and development, innovation, and manufacturing. As a non-mission agency, NSF's extensive activities in basic research complement investments in other areas essential to the health of the scientific enterprise, as recognized by the COMPETES reauthorization. The Board fully supports the FY 2012 budget request as meeting the needs to achieve the mission of the National Science Foundation.

Q9. The Administration plans to invest $3.4 billion across the federal government for STEM education, including many new initiatives primarily at the Department of Education. While the Department of Education should certainly take a more active role in STEM, do you know what the rationale is for shifting this support from NSF to Education? How actively involved can NSF be in decisions being made at the Department of Education on STEM-related issues? What steps are being taken to ensure that these new activities are research-based and will have input from not only the education community but also the scientific community?

A9. The Board and NSF management will continue to work in collaboration to ensure the agency's activities are grounded in solid research results. For education activities, the Board's Committee on Education and Human Resources (CEH) provides input and guidance regarding the agency's efforts in STEM education research. The agency's directorate of Education and Human Resources has built a productive relationship with the Department of Education over the past several years, and reports on these interagency efforts regularly to CEH. In 2007, NSB's report "A National Action Plan for Addressing the Critical Needs of the United States STEM Education System" recommended the Office of Science and Technology Policy create a standing committee on STEM education within the National Science and Technology Council (NSTC). That recommendation has been implemented and will provide additional support for interagency education activities.

Q10. Everyone touts the importance of America COMPETES and the America COMPETES Reauthorization Act, but rather than sticking to funding proven and established programs at NSF like Noyce Scholarships and the Math and Science Partnership (MSP), the FY 12 budget request reduces their funding by $20 million in order to create a new teacher development program. The Noyce program was expanded in the original COMPETES Act to include a new program called 10,000 Teachers, 10 Million Minds. The FY 12 budget is now calling for a NEW 100,000 STEM teachers program with the same hoped for end result. Other than focus being at the Department of Education versus NSF, do you have any idea how this new program will be different? Is there a problem with the program currently in place at NSF?

A10. The Board believes that continual evolution of research and education programs is a positive element of the Foundation's programs. The continual assessment and reassessment of programs allows the agency to deliver high quality efforts in all of its activities.

For your questions regarding the specific differences between the existing program and this new program and problems with the current NSF program, the Board defers to the National Science Foundation's answer on these matters.

Q11. A few weeks ago, the new National Science and Technology Council STEM Education Committee convened. Please describe the role NSF will play in this Committee. Do you think it will be able to effectively identify duplicative and ineffective STEM programs across the federal government? And if so, how and what actions can be taken to save the American taxpayer from continuing to support these programs?

A11. In 2007 the NSB released A National Action Plan for Addressing the Critical Needs of the United States STEM Education System. In the report the board recommended the OSTP create a standing committee on STEM education within the

National Science and Technology Council (NSTC). The first meeting of the new Science, Technology, Engineering and Math committee was held on March 4th. The committee includes 11 federal agencies that play a role in STEM education and is co-chaired by Associate Director of Science Carl Wieman and NSF Director Subra Suresh.

In the first meeting the group discussed how to create a detailed inventory of Stem Ed programs and a five year strategic plan for STEM education as require in the *America COMPETES Act*. Members also discussed how assessments can be used to ensure the quality and cost effectiveness of STEM programs. We are confident that the NSTC committee will develop an appropriate response to addressing issues of ineffective and duplicative Federal programs for STEM education.

Q12. NSF is proposing to eliminate funding for the Research Initiation Grants to Broaden Participation in Biology program (RIG) because "the number of proposals from underrepresented groups did not increase." Is this the same case for other broadening participation programs within the Foundation? What evidence do we have that these programs are achieving the desired results? Why do we need yet another new $20 million "Transforming Broadening Participation through STEM (TBPS) program? How involved is the Board in decisions such as this?

A12. Through its oversight capacity, the Board ensures that its policy guidance to the NSF is addressed. Broadening participation efforts for the STEM enterprise has been a continual emphasis for the Board as reflected in several of our reports. Ensuring that all citizens are represented in the STEM community strengthens the research community as a whole. With regard to decisions based on the performance of specific programs, the Board defers to the Foundation management.

Question Submitted by Representative Sandy Adams

Q13. As mentioned in the hearing, within the Education and Human Resources Directorate, there is a Human Resource Development Division that up until the FY 12 budget request was intended to "play a central role in increasing opportunities in STEM education for individuals from historically underserved populations -minorities, women, and persons with disabilities." The FY 12 budget request realigns the Division, reducing funding for and shifting several programs to another Division. Of the $160 million budget request for the Division ($20 million of which is for a new broadening participation program), only $1.6 million is available for "increasing opportunities in STEM education" for women and zero is available for "increasing opportunities in STEM education" for persons with disabilities. What role does the National Science Board play in decisions like this or other decisions that alter the focus or scope of a particular program, Division or Directorate?

A13. Through its oversight capacity, the Board ensures that its policy guidance to the Foundation is addressed, including a strong focus on broadening participation in science and engineering by underrepresented groups, including women, specific ethnic groups, and persons with disabilities. The Board ensures that NSF sets priorities, makes hard programmatic budget decisions and, as a result, obtains the greatest benefit from the funds provided to implement the NSF mission in this area.

Question Submitted by Representative Randy Hultgren

Q14. Given the size and commitment increasingly required for cutting-edge science to be successful and the complexity of the federal planning, review, and approval processes, the U.S. must be able to demonstrate its ability to construct large scale science facilities which will define the future of specific fields. Moreover, our nation's ability to deliver on these facilities portends important implications for multi-lateral international scientific collaborations on projects such as DUSEL and future projects around the globe.In December, the National Science Board made a decision to not provide any additional funding for DUSEL beyond the Preliminary Design Review, and despite support from the National Science Foundation and commitments made to the project and this Congress.How will the NSB work with NSF, DOE, and Congress, to ensure that predictable steady forward movement continues avoiding preventable increases in long term expenses and significant setbacks to the scope of the scientific discoveries and to the future of large interagency collaborations?

A14. The NSB is committed to fostering the Nation's leadership in science, engineering, mathematics and education. The Board recognizes the potential for significant and fundamental discoveries in physics that could result from experiments conducted in a deep underground research laboratory. The NSB will continue to work with the Director of NSF as NSF, the Department of Energy and the White House explore options for advancing deep underground science.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Patrick Gallagher, Under Secretary of Commerce for Standards and Technology and Director, National Institute of Standards and Technology

Questions Submitted by Chairman Ralph Hall

Q1. How do NIST's extramural programs—the Manufacturing Extension Partnership (MEP), the Technology Innovation Program (TIP), the Baldrige Performance Excellence Program (BPEP), and the proposed Advanced Manufacturing Technology Consortia Program (AMTech)—support NIST's underlying mission? I have always supported the MEP program and know what a difference it has made to Texas, so that is the easiest of the three programs for me to justify funding in these difficult fiscal times. But for the record, why should the federal government provide these services, which directly support for-profit entities? What if, if any, duplication exists among these programs?

A1. NIST's core mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST extramural programs and the proposed AMTech program are vital to NIST's technology mission and critical to strengthening U.S. innovation and industrial competitiveness. Each program addresses unique critical needs and gaps spanning the entire innovation and technology development cycle. From incentivizing and supporting long-term industry-led directed basic research to accelerating technology deployment and adoption by America's manufacturers, the NIST extramural programs along with the NIST laboratories, provide a critical infrastructure that supports the type of high-tech innovation, development, and manufacturing that is critical for our nation's long-term sustainable economic growth and job creation.

- *AMTech* will collapse the timescale of technological innovation by including partners that span the innovation lifecycle from idea to discovery, from invention to commercialization. Through cost-sharing and a common research agenda, these consortia would support the development of innovative new technologies directed at creating high-wage jobs and economic growth across the industry sector. These consortia will develop road-maps of critical long-term industrial research needs and provide support for research and equipment at leading universities and government laboratories directed at meeting these needs. This approach deepens industrial involvement in determining how to best leverage government resources to promote technological innovation.
- *TIP* funds small companies and consortia of small companies and universities to support high-risk transformational Research and Development. The cost-share provisions of TIP enable TIP to leverage significant non-federal investment for high-risk, cutting edge technologies, and serves as an important source of funding when no other sources are reasonably available.
- *MEP* helps small and medium-manufacturers strengthen their competitive positions by accelerating the adoption of technological innovations, facilitating the adoption of environmentally sustainable business practices, promoting renewable energy initiatives, fostering market diversification, and connecting domestic suppliers to manufacturers to assist manufacturers in successfully competing over the long term in today's complex global manufacturing environment.
- The *Baldrige Performance Excellence Program* improves the performance of U.S. organizations by: raising awareness about the importance of performance excellence to economic competitiveness, providing organizational assessment tools and criteria, educating leaders about the practices of best-in-class organizations, and recognizing national role models and honoring them with the only Presidential Award for performance excellence.

Q2. The Technology Innovation Program (TIP), created in 2007 by the original America COMPETES Act, updated the Advanced Technology Program (ATP) by changing the program and adding some very challenging new goals. The TIP

is directed to provide grants for cutting edge research that meets critical national needs, in areas in which no one else is working. That means the TIP-funded work must be very narrow and in extremely challenging areas. How many awards were distributed since the program has started? How can a program, funded currently at about $70 million, achieve those goals? In your testimony you mentioned NIST will make at least one award in the next year; at that rate, how successful can this program be?

A2. The Technology Innovation Program addresses challenges that justify government attention in areas of critical national need by supporting innovative high-risk, high-reward research. The program supports small and medium-sized businesses, institutions of higher education, national labs, nonprofit research institutions and other organizations, where government attention is justified because the magnitude of the problem is large and no other sources of funding are reasonably available.

Since its authorization, the program has awarded 38 grants during the period FY 2008-2010, representing a TIP investment of approximately $-136 million, for a total investment of about $ 280 million in new high-risk, high-reward research:

- In 2008, $-42.5 million from TIP funds supported nine projects in advanced sensor technologies for civil infrastructure such as roads, bridges, and water systems, for a total of $ 88.2 million in new research (TIP + awardee cost share).
- In 2009, TIP funded twenty projects at $-71 M, for a total potential new research investment of $-145.6 M, to address critical national needs in manufacturing and civil infrastructure.
- In 2010, TIP provided more than $-22.2 million for nine projects for advanced manufacturing research in electronics, biotechnology and nanotechnology, for a total of $45.9 million in new research.

Off the 38 awardees, 35 are either small-business, single company projects, or include a small business as a member of the research joint venture.

The cost-share provisions of TIP enable TIP to leverage significant non-federal investment for high-risk, cutting edge technologies. Thus, a relatively small investment for TIP can still have a significant impact. Despite being a young program, results from the R&D are already being shared and tested, which is indicative of the impact of the program. Technologies in civil infrastructure have been tested in state highway facilities and several of the projects have agreements with state transportation authorities (e.g. California, Michigan, and Massachusetts) to serve as test beds for this next generation of technologies. The scientific findings from these projects are also being actively shared within the scientific community, enabling these efforts to benefit R&D in areas beyond the organizations partnering with TIP. In March 2011, organizations working with TIP in the 17 civil infrastructure projects presented 47 research papers at a smart structures conference hosted by SPIE, the international society for optics and photonics. This interaction across scientific disciplines allows TIP participants to share important R&D findings that can subsequently be used by other researchers. These early research results and strong partnering relationships suggest the research currently underway has laid the foundation for transforming today's research into tomorrow's solutions.

With regard to 2012, NIST expects to hold a funding competition in one or more of the following research areas: advanced robotics and intelligent automation, health care, water, civil infrastructure technologies, and manufacturing. Proposals received in response to the open competition will be subject to peer review, and multiple awards will be made based on the results of the competition.

Q3. You have discussed that the decrease in funding for the Baldrige Performance Excellence Program (BPEP) reflects the Administration's goal of transitioning the program out of federal funding. Could you please describe the purposes of the program, and why thy government has identified this as an area for which NIST should examine additional private sector means of support?

A3. Purpose of the program: The Baldrige Performance Excellence Program exists to improve the competitiveness and performance of all U.S. organizations. It does this in three ways: by (i) defining performance excellence, with the highly-regarded and adopted Criteria for Performance Excellence—which reflect the leading edge of validated management practice and have resulted in 2.5 million page views in 2010 alone; (ii) recognizing performance excellence, with an annual Presidential Award for national role model organizations that successfully implement the Criteria to achieve world class operations and results; and, (iii) performance excellence education and promotion (for example, the recent Quest for Excellence conference in Washington, DC. at which almost 900 attendees learned best performance manage-

ment practices from current and former Baldrige winning organizations from all sectors of the U.S. economy).

Examining private sector support: The Baldrige Program already enjoys a public-private partnership with the Baldrige Foundation and through in-kind contributions from Award winning organizations, as well as the very substantial volunteer efforts of the Board of Overseers, Panel of Judges, and Board of Examiners. More than 35 states operate Baldrige-based programs to assist industry across the United States on a local level with using the Baldrige Criteria and process to improve their operations. Around 2,270 State Baldrige-based examiners volunteered an estimated $29.5 million in services to evaluate 1,350 organizations at the state level in 2010. In 2010, 578 dedicated professionals volunteered as national Baldrige examiners and contributed roughly $8.8 million in services; the Baldrige public-private partnership enables this volunteer network. Given the Program's 22-year history of leveraging partners in industry and the states, the Administration believes this program could be best sustained as a private sector led and funded activity.

Questions Submitted by Representative Eddie Bernice Johnson

Q1. As you mention in your testimony, the budget request includes funding to continue NIST's work to accelerate the development of standards for electric health records and health information technology. At the same time, the Office of the National Coordinator for Health IT (ONC) at the Department of Health and Human Services is continuing its work under the American Recovery and Reinvestment Act to identify and adopt standards, specifications, and certification criteria for health information technology. To what extent are NIST and ONC collaborating on health IT standards to ensure that each agency's efforts are coordinated and not duplicative, and that NIST's expertise in information technology standards is being fully utilized?

A1. Since 2004, NIST has worked closely with the Department of Health and Human Services' Office of the National Coordinator for Health Information Technology (HHS/ONC). Central to this close collaboration and ongoing dialogue is ensuring that Health IT initiatives and outcomes are complimentary and in line with Federal mandates. For example, in response to the Health Information Technology for Economic and Clinical Health Act (HITECH) Act, NIST is responsible for pilot testing of standards and implementation specifications and coordinates closely with ONC to assure the efficient implementation and use of such standards. Leveraging NIST expertise is also central to our close collaboration. For instance, NIST, with a proven track record and expertise in the establishment of conformance testing programs, is responsible for establishment of a conformance testing infrastructure and technical test beds for Health IT products—critical to ensuring the interoperability of electronic health records.

HHS/ONC is responsible for facilitating the development of standards and implementation specifications that will ensure interoperability of electronic health records. As part of the strategy, HHS/ONC will be identifying product neutral test conditions to verify conformance of health IT products. NIST is collaborating with HHS/ONC to implement the test conditions in technical test bed infrastructure that can be used to test products. NIST's experience in the establishment of pilot test infrastructure will be central to HHS/ONC development and implementation of the certification and testing program for all health IT products and will ensure the interoperability of electronic health systems.

Q2. A significant amount of attention has been paid in recent years to the need to improve the quality of health care and reduce health care costs in this country. One way to do this is to strengthen our ability to detect and treat diseases or other medical conditions quickly, cheaply, and effectively. Many have argued that NIST has a critically important foundational role to play in this area.

- *Aside from NIST's important work in the area of health information technology, how is NIST's role in health care-related research reflected in the FY 2012 budget?*

A2. Health care-related measurement technologies and standards are an important focus of NIST resources across a range of specific application areas.

- In the FY 2012 budget, a new initiative, "Measurement Science and Standards to Support Biomanufacturing," (+ $9.5 million) is intended to support the creation of agile processes required for next generation biotechnology medicines. NIST will work with the FDA and industry to develop innovative solutions to existing technical issues and help achieve consensus in standards development related to biomanufacturing.

- Funds allocated to NIST laboratories in the FY 2012 budget will support ongoing efforts in health care-related areas of medical imaging and clinical diagnostics, including:
  - The optical medical imaging program at NIST, whose goal is to develop standards and measurement quality assurance to improve surgical and clinical lighting.
  - New bioimaging methods and materials to improve the characterization of cells and tissues, leading to more efficient and accurate clinical diagnoses of cancer and other diseases, helping to advance personalized medicine.
  - Body Area Network technology tools that analyze and help mitigate potential interference from wireless medical devices, such as wearable or implantable medical sensors that continuously monitor blood pressure or deliver insulin to a diabetic.

Q3. How does NIST decide where it is going to make specific health care-related investments? Are those decisions driven by any sort of overarching strategic plan on the research that is needed in this area, or are NIST's investments merely responsive to the immediate needs of other Federal agencies?

A3. Activities in health care-related measurement and standards development support the NIST mission to strengthen U.S. innovation and industrial competitiveness, and must be grounded in the needs of the industrial community as well as other Federal agencies. Accurate and comparable measurement science and standards will underpin quality health care.

- Following on a NIST workshop with the broad bioscience community, in July 2009 NIST produced "Measurement Challenges to Innovation in the Biosciences: Critical Roles for NIST," which outlines high level application areas and priority measurement needs that should be addressed by NIST to realize the potential economic and societal benefits of advances in health care.
- In light of the reorganization this past October, NIST continues to refine its bioscience portfolio. Continuous efforts to engage with the health care community (e.g., businesses, other Federal agencies, and advocacy groups) via partnerships and workshops help NIST to identify and authenticate un-met measurement needs to inform the NIST strategy in this area.
- Interactions with other Federal agencies are important to leverage NIST's capabilities in order to address national needs. For example, meetings with representatives from the Food and Drug Administration's Critical Path Initiative identify research and development opportunities for NIST to contribute to efforts to transform the development, evaluation, and manufacture of FDA-regulated products. Similarly, collaborations between NIST laboratories and the National Cancer Institute (National Institutes of Health) facilitate targeted measurement science in the area of cancer research.

Questions Submitted by Representative Ben Quayle

Q1. The Department of Commerce intends to codify a National Program Office for NSTIC headed by NIST, and the FY 12 request includes $25 million to fund the establishment of the office and a new grant program related to this work. What will this office do, and why is it at NIST? Who will be eligible to receive the pilot grants, what is the purpose behind them, and how large will the awards be? How has industry been involved in the National Strategy? Would it be more appropriate for the private sector to figure out the solutions to these problems without the government being involved?
What will this office do, and why is it at NIST?

A1. The National Program Office (NPO) for the National Strategy for Trusted Identities in Cyberspace (NSTIC) will be responsible for coordinating the processes and activities of organizations that will implement the Strategy. NIST—with its long history of working collaboratively with the private sector to develop standards and best practices for cybersecurity and identity management—is uniquely suited to work with the private sector to bring the collective expertise of the nation to bear in implementing the Strategy. The NPO will formally coordinate the work NIST has been doing for several years in our existing cybersecurity and identity management programs and ensure that the portions of this work relevant to NSTIC are properly aligned. The NPO will lead the day-to-day coordination of NSTIC activities, working closely with the Cybersecurity Coordinator in the White House. The National Program Office will:

- Promote private-sector involvement and engagement;
- Support interagency collaboration and coordinate interagency efforts associated with achieving programmatic goals;
- Build consensus on policy frameworks necessary to achieve the vision;
- Identify areas for the government to lead by example in developing and supporting the Identity Ecosystem, particularly in the Executive Branch's role as a provider and validator of key credentials;
- Actively participate within and across relevant public—and private-sector forums; and
- Assess progress against the goals, objectives, and milestones of the Strategy and the associated implementation activities.

Who will be eligible to receive the pilot grants, what is the purpose behind them, and how large will the awards be?

Identification of pilot awardees will use well-established Federal Government outreach processes to include requests for information and proposals. Criteria for pilots will be based on the Strategy's four guiding principles—that identity solutions should be (1) privacy-enhancing and voluntary, (2) secure and resilient, (3) interoperable, and (4) cost-effective and easy to use. Proposals will be evaluated competitively before making awards. Pilots are necessary for most new technical solutions and can help test feasibility of different architectures, policies, use cases, and technologies. They are key to identifying and overcoming technical or policy barriers to adoption. And they can bring different sectors together to demonstrate key NSTIC concepts and refine the model. The value of the individual awards will vary depending on the pilot criteria and current expectations include at least three pilots in FY 12.

How has industry been involved in the National Strategy?

Many stakeholders provided input as the draft Strategy was refined, particularly after an early draft of NSTIC was publicly released in June 2010. Organizations representing 18 different business and infrastructure sectors and 70 different nonprofit and federal advisory groups were consulted in developing the Strategy.

Would it be more appropriate for the private sector to figure out the solutions to these problems without the government being involved?

One reason leading private sector groups like TechAmerica and the U.S. Chamber of Commerce have supported NSTIC is a recognition that the government has an important role to play. The private sector has been working for years on solutions to identity and security challenges, but by its own admission has struggled with finding consensus on issues such as standards for interoperability and privacy. A joint letter sent February 17, 2011 from TechAmerica, the Information Technology Industry Council and the Business Software Alliance advocated: *"We need a partner in government to help us move trusted identities into the 21st century. We need the government's involvement to: examine and align governments activities with industry; build consensus on the legal and policy frameworks to enhance privacy, free expression, and open markets; work with industry to identify new standards; support and coordinate interagency collaboration as well as international collaboration; and promote pilot projects and other implementations."*

Q2. What is the status of development for standards for interoperability in Health Information Technology? When will the job be "completed"?

A2. Much work has been done to date by NIST and others in developing interoperability standards for Health Information Technology, and NIST will continue to work with Standards Development Organizations and industry stakeholders, both directly and in collaboration with of the Department of Health and Human Services' Office of the National Coordinator for Health Information Technology (HHS/ONC). The HHS/ONC has requested that NIST develop a laboratory accreditation program (LAP) for organizations to be accredited to test health information technology (HIT) for purposes of the permanent certification program. Based on NIST's technical expertise and the strong relationship formed between the ONC and NIST during the successful implementation of a temporary certification program, the use of the National Voluntary Laboratory Accreditation Program (NVLAP) is expected to enhance testing under the permanent certification program.

Questions Submitted by Representative Randy Neugebauer

Q1. Dr. Gallagher, what type of opportunities does NIST provide to leverage resources in coordination with educational institutions for activities such as cooperative research opportunities and partnerships?

A1. NIST provides various opportunities to leverage resources in coordination with educational institutions, including the following:

- NIST has numerous strong partnerships with educational institutions of mutual benefit, and these programs encourage student interest and participation in Science, Technology, Engineering, and Mathematics (STEM) programs. Through a variety of programs, we bring high-school students through postdoctoral fellows, and middle school teachers to our campuses for unique programs that have a direct impact on STEM education. We also support faculty researchers and students through a variety of competitive grants programs. Programs include:
- NIST's Postdoctoral Program supports a nationwide competitive postdoctoral program administered in cooperation with the National Academy of Sciences/ National Research Council,
  - NSF-funded Summer Undergraduate Research Fellowships,
  - The NIST Summer Institute for Middle School Science Teachers,
  - The NIST Research Experience for Teachers Program, and
  - The NIST Measurement, Science, and Engineering Grant Program.
- NIST operates research organizations in four locations, in conjunction with leading academic institutions to promote cross-disciplinary collaborations that accelerate research results:
  - JILA, a world class physics research institute operated jointly with the University of Colorado, Boulder,
  - The Institute for Bioscience and Biotechnology Research, a partnership with the University of Maryland Biotechnology Institute,
  - The Joint Quantum Institute for advancing quantum physics research, operated jointly with the University of Maryland, and
  - The Hollings Marine Laboratory, in Charleston, SC, a national center for coastal ocean science, in which NIST is one of five federal, state, and university partners.
- NIST hosts about 2,600 associates and facility users who work with about 2,900 NIST staff members at two main campuses in Gaithersburg, Md., and Boulder, Colo. Most of these associates are affiliated with universities.
- Advanced Manufacturing Technology Consortia (AMTech), a new public-private partnership, will develop roadmaps of critical long-term industrial research needs as well as fund facilities, equipment, and research at leading universities and government laboratories.
- The Baldrige Performance Excellence Program has been expanded to include educational institutions.
- NIST has also facilitated the development of unique research facilities in educational institutions throughout the country with support from the NIST Construction Grants Program, and American Recovery and Re-investment Act (ARRA) funds. Examples include a state-of-the-art research facility for fundamental and applied physics at Rice University partially funded by $11.1 million in ARRA grant money, and $9.5 million for the Center of Excellence in Nano Mechanical Science and Engineering at the University of Michigan, Ann Arbor, which will facilitate research at the intersection of mechanical engineering and nanometer-scale science and technology.

Q2. Your budget request includes a proposal to allocate $500 million to NIST from an estimated $27 billion in revenues from the FCC's proposed spectrum auctions. These funds, under your proposal, would be used for the operation of the Public Safety Innovation Fund. How would this program operate if the assumptions about funding levels from the proposed spectrum auctions do not come to fruition?

A2. The advent of broadband technologies and the Administration's proposal to allocate an additional 10 MHz to public safety create a new opportunity to build from the ground up a robust, reliable, secure and scalable communications network for addressing public safety needs. The Administration has proposed $ 100 million an-

nually through fiscal year 2016 for NIST to partner with industry and public safety organizations on research, development, and demonstration activities aimed at new standards, technologies, and applications to advance public-safety communications.

If no funding is available for this activity, NIST will continue to research and test broadband public safety communications systems and participate in the standards process, though at a much reduced level. NIST's 700MHz Demonstration Network project is the only network in the country that is testing how equipment operates in the public safety 700MHz band in a vendor-neutral environment. If funding is limited or unavailable, many of the project's goals and planned deliverables will take much more time and may not come to fruition, including the delivery of objective technology evaluations; test reports that public safety can use in development of requests for proposals; technical recommendations to standards development organizations; recommendations that public safety organizations can use to create public safety Long Term Evolution (LTE) profiles; and technical information delivered to the Federal Communications Commission (FCC) to inform policy development.

Questions Submitted by Representative David Wu

Q1. With respect to earthquake resiliency, how do building codes and construction practices in the United States compare to building codes and construction practices in Japan? How do they compare to those in Chile?

A1. The recent earthquake damage in Japan was limited, partly because the epicenter was almost 100 km (60 miles) from shore, but mostly due to the building codes that Japan has in force. Japanese building codes are more stringent than those in the United States. They call for building designs that are stronger and consequently more expensive. Note that the majority of the damage in Japan was caused by the tsunami.

- An example of a different building code is that Japan has gone further than the United States in outfitting new buildings with advanced devices called base isolation pads and energy dissipation units to dampen the effect of the ground's shaking during an earthquake. These units, built into the internal structural skeleton of the buildings, comprise of hydraulic cylinders that contract and elongate when the building sways, absorbing the energy of the motion. Buildings built to these codes were able to withstand the tremors from the Japan earthquake without collapsing.

The Chilean building code has adopted by reference key aspects of U.S. model building codes (with some Chilean exceptions). Examples of differences include:

- U.S., but not Chilean, codes contain special provisions that are triggered by building irregularities in plan or elevation views. There are numerous damaged buildings in Chile having significant irregularities (such as narrowing of walls near the base of the building) attributable to the lack of these special provisions.
- Some Chilean detailing practices (e.g., numerous thin and relatively lightly reinforced structural walls) differ from U.S. practice. Some of the buildings that appear to have been designed and detailed to the Chilean code provisions did not perform as expected, and were extensively damaged.

The major Chilean earthquake in 2011 has provided a valuable opportunity to evaluate the performance of structures built in a manner similar to those in the United States. Under the National Earthquake Hazard Reduction Program (NEHRP), agencies are working to document findings and translate them into lessons for the United States.

Questions Submitted by Representative Donna Edwards

Q1. The budget request for FY 2012 includes funding for NIST to continue its work on smart grid standards, as mandated by the Energy Independence and Security Act of 2007. Can you give us a brief update on where we are on smart grid standards and what additional work NIST is expecting to carry out in FY 2012?

A1. NIST has made a significant progress in its role to coordinate the development of Smart Grid interoperability standards. Noteworthy milestones include:

- **Identified initial set of Smart Grid standards for consideration by the Federal Energy Regulatory Commission (FERC)** – October 2010

  NIST identified five foundational families of international standards as ready for consideration by FERC. These standards, developed by the International

Electrotechnical Commission (IEC), are essential to uniform and interoperable communications systems throughout the grid and will accommodate the evolution of the grid and integration of new technologies.

- **Published Guidelines for Smart Grid Cyber Security** 9 September 2010

This three-volume set of guidelines, prepared by the 450-member Cyber Security Working Group (CSWG), provide the technical background and details that inform organizations' efforts to securely implement Smart Grid technologies.

- **Established Smart Grid Federal Advisory Committee (SGFAC)**– September 2010

The Committee provides input to NIST on the Smart Grid standards, priorities and gaps, and on the overall direction, status and health of the Smart Grid implementation by the Smart Grid industry including identification of issues and needs. Input to NIST will be used to help guide Smart Grid Interoperability Panel activities and also assist NIST in directing research and standards activities.

- **Published first release of the NIST Framework and Roadmap for Smart Grid Interoperability (SGIP)** 9 January 2010

NIST released an initial list of 75 interoperability standards with applicability to the Smart Grid, a preliminary cyber security strategy, a Smart Grid conceptual reference model, and priority action plans that address areas where there are critical gaps in Smart Grid standards.

- **Launched Smart Grid Interoperability Panel (SGIP)** 9 November 2009

NIST established the SGIP as a public-private partnership to provide technical support to NIST as it coordinates the development of interoperability standards. The SGIP currently includes over 600 member organizations and 1700 participants from 23 Smart Grid-related stakeholder groups.

In FY 2012, NIST plans to publish an update to the NIST Framework and Roadmap for Smart Grid Interoperability, continue support of the Smart Grid Interoperability Panel, develop a testing and certification framework for Smart Grid systems and devices, and build the necessary measurement science to support the development of new Smart Grid technologies.

Q2. It is our understanding that the funding levels proposed for NIST in the Fiscal Year 2011 Continuing Resolution that recently passed House would mean that NIST would be unable to continue the contract for the Smart Grid Interoperability Panel, which would severely degrade and perhaps even halt altogether NIST's smart grid standards work. Is that true? What would that proposed CR mean for NIST's smart grid standards effort?

A2. The Smart Grid Interoperability Panel, established by NIST in 2009, is a public-private partnership made up of over 600 member organizations that supports NIST in its role to coordinate the development of Smart Grid interoperability standards. The current $5 million contract for the Smart Grid Interoperability Panel (SGIP), which was initiated with funds from the American Recovery and Reinvestment Act of 2009, ends this August, and a Request for Proposals for a new contract must be issued by April to prevent the suspension of SGIP activities. NIST is looking at funding options to ensure some level of SGIP support in order to prevent having to suspend the SGIP's technical functions.

Appendix II:

Additional Member Statements

SUBMITTED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Mr. Chairman, thank you for holding today's hearing on the National Science Foundation's (NSF's) and the National Institutes of Standards and Technology's (NIST's) budget requests for Fiscal Year 2012 (FY12).

First, NSF requests $7.7 billion in FY 12, a 13 percent increase in funding. This funding level steps back from the administration's commitment to double funding for NSF within ten years. It is my hope that as our economy continues to recover, the administration will recognize the importance of making up these losses in future budgets. NSF plays a critical role in funding basic science research at labs and universities around the country, and I have seen its benefits first-hand in my district. In the last five years, NSF has provided $19.5 million in research funding to Southern Illinois University Carbondale in my district and $3.7 million to Southern Illinois University just outside my district.

As a member of the Congressional Manufacturing Caucus, I strongly support NSF's investment of $190 million for Advanced Manufacturing Research. This research will ensure we remain the most innovative, efficient, and skilled manufacturing sector in the world and that our facilities use the most advanced technology.

In addition, I am pleased the President's overall budget makes a strong commitment to improving Science, Technology, Engineering and Mathematics (STEM) Education funding across the federal government. The FY 12 budget requests $3.4 billion, including $100 million to recruit 10,000 new STEM teachers this year and 100,000 teachers over the next ten years. While this expansion will encourage more students to enter STEM and become educators, the budget shifts STEM funding away from NSF and to the U.S. Department of Education. These two agencies should work together to ensure we invest in the most productive, efficient STEM programs.

Second, NIST requests $1 billion in FY 12, a 16.9 percent increase above the FY 10 funding levels. In particular the budget makes two key investments to improve manufacturing in the U.S. and ensure we use federal research funding to create jobs and maintain a competitive workforce.

NIST requests $142.6 million, a 14 percent increase, for the Manufacturing Extension Partnership (MEP) to expand their programs to provide technical support and links to community colleges and other partners for small and medium-sized manufacturers. There are great benefits to our communities where strong MEPs exist, like in my district. Companies that work with the Illinois Manufacturing Extension Center (IMEC) see, on average, 22 new or retained jobs and $100 in sales and productivity gains for every $1 they invest in IMEC, which strengthens the economy.

Finally, the FY 12 budget also establishes an Advanced Manufacturing Technology Consortia (AMTC) within NIST to build partnerships with NSF, industry, and colleges and universities around the country. These investments will allow NIST to promote manufacturing innovation, build partnerships between researchers and industry, ensure our manufacturing workforce is prepared for future opportunities and challenges, and increase U.S. exports.

I welcome our witnesses, and I look forward to their testimony.

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